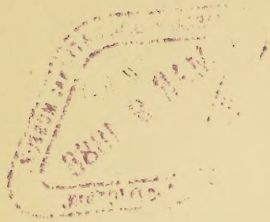

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XII.—*Contributions to the Geology and Physical Geology of the Lower Amazonas. The Ereré—Monte-Alegre District and the Table-Topped Hills.* BY CH. FRED. HARTT.

XXIII.—*On the Devonian Brachiopoda of Ereré, Province of Pará, Brazil.* BY RICHARD RATHBUN.

[From the Bulletin of the Buffalo Society of Natural Science, January, 1874.]

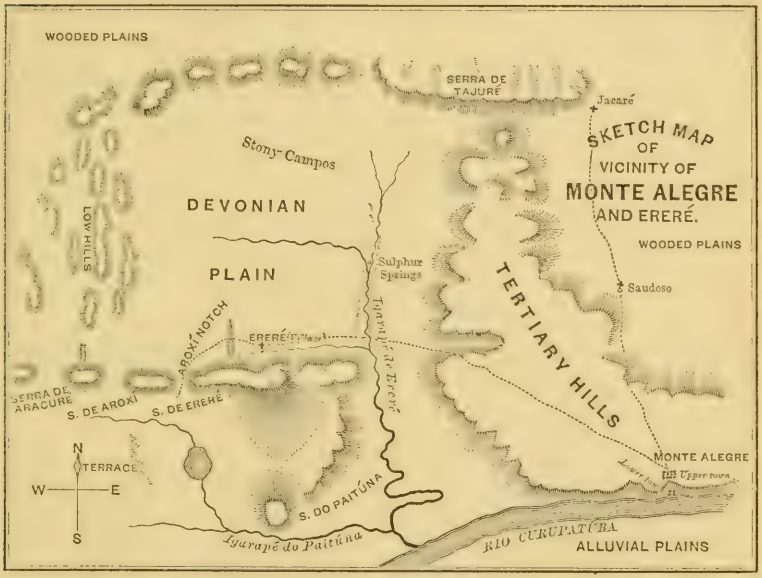
XXII. Contributions to the Geology and Physical Geography of the Lower Amazonas

BY CH. FRED. HARTT,

Prof. of Geology in Cornell University.

[*Read before this Society, January* 2, 1874.]

THE ERERÉ-MONTE-ALEGRE DISTRICT AND THE TABLE-TOPPED HILLS.



Ascending the Amazonas from Pará, the topographical features observable from the river for the first 300 miles, are very monotonous. With the exception of the immediate vicinity of Pará, Breves and Gurupá, where the land rises to a height of twenty to thirty feet above tide-level, the country is perfectly flat, scarcely above water even in the dry season, and of recent origin. Where

the land is perennially wet, as along the *furos** connecting the main river and the Pará estuary, it is so densely forest-clothed that, from the water, one sees nothing but foliage, and the land-effect is produced not by *terra firma*, but by the forest-wall that at once borders and limits the channels.

Were the vegetation removed from the region just mentioned, the vision of the traveler, instead of being shut in everywhere by the forest, would range over a tract as level as the sea. Enormous mud flats, partially covered by every tide, nowhere more than a very few feet out of water, traversed by a network of deep channels, and diversified by lakes, would be seen stretching away to the horizon on every side, only here and there a *torrão*, like that of Breves, rising above the general dead level. Such would be the appearance of the Breves district during the dry season if deprived of trees; but, during the rains, the Amazonas deluges the whole region and pours over it in one broad sheet into the bay of Marajó. To rightly appreciate the topography of the lower Amazonas, we must eliminate the effect produced upon us by the vegetation. True it is that the alluvial lands, just described, depend upon the forest both for their origin and existence, but one is apt to mistake forest topography, if I may use such a term, for land topography, and count for more than its real geographical value, a district whose height and limits are intensified or defined by forest. After having made six voyages between the bay of Marajó and the main river, I am satisfied that, one reason why voyagers have so much doubted whether the, so called, Pará river should be considered a mouth of the Amazonas, is largely due to the fact, that the forest prevents a just appreciation of the magnitude of the united channels of the Breves district, while, at the same time, the size of the Tocantins has been much over-estimated. Above Trocará this river is, during the dry months, only a small, narrow stream, while, in the lower course, it is not a true river, but a wide, extremely shallow, tidal estuary, the upper part of which is in process of filling up with sand, brought down by the river. The enormously wide, lower reaches, that open broadly into the bay of Marajo, are swept by very strong tides, and are being silted up by Amazonian mud. Travelers who hastily pass through

* A *furo* on the Amazonas is a channel that connects two different streams and it differs from a paraná-merím, which is a side channel that leaves a river and joins it again lower down.

the Breves district, and trust to maps and the glimpses they get of the mouth of the Tocantins, may set down the Pará as simply the extension of that river, but they are not correct. The Tapajos and Tocantins are rivers of very nearly the same size, but the waters of the former river, on issuing from its mouth, are crowded by the mighty torrent of the Amazonas against its bank, as if they were a mere brook. To attribute the fresh waters of the Pará to the Tocantins, is like referring a giant's work to a pigmy. The Tocantins, Mojú, Acará and all the true rivers emptying into the Pará, taken together, would not, during the dry season, furnish enough water to make more than a respectable Amazonian paraná-merím, and they would be utterly insignificant, in comparison with the united Breves furos. Of course the rivers just enumerated must be enormously increased in volume during flood time, but even at that time they cannot compare with the wide Amazonian flood which then pours through channel and forest over the Breves lowlands.

It must not be forgotten that these lowlands are bordered on the east by the higher lands of Marajó and on the south-west by those of the southern side of the Amazonian valley, and the traveler on the lower Amazonas should remember that the flat, alluvial banks, which so monotonously accompany the river, do not extend very far into the interior. If we ascend the Tocantins, we shall encounter the higher grounds at Cametá, and the town of Gurupá is built on, what appears to be a low spur of these same lands. They reappear again at the mouth of the Xingú, to the westward of which, at a greater or less distance from the river, they stretch in a line of bluffs to the Tapajos.

Ascending the Amazonas by the ordinary route, one sees no high lands on the northern side of the river, until, having passed the mouth of the Xingú, the table-topped serras of Parú rise before one, stretching along the river in patches nearly to Praïnha, beyond which soon come into view the highlands of the Monte-Alegre district. It is to the Geology and Physical Geography of these northern Highlands and their vicinity that I now invite the attention of the reader.

The villa of Monte-Alegre is situated a few miles above the mouth of the rio Curupatúba,* one of the northern affluents of the Ama-

* From the Lingoa geral *Kurupá*, a port, and *tŷ'ua*, a place of. The name appears to have been primarily applied to the village, because of its convenient landing place. Rio Curupatúba

zonas, and is distant 350–360 miles nearly directly west of the city of Belém or Pará.

On the maps, the Curupatúba is usually represented as a large river, taking its rise in the highlands of Guiana, to the north-westward of Monte-Alegre, and which, shortly before entering the Amazonas, receives by a short outlet the waters of a large lake. According to Sr. Ferreira Penna* this is inexact. The river that descends from the interior is called the Mãecurú † (or Maycurú) and it empties directly into the lake. This river has never been explored and nothing is known of its upper course. The lower part is bordered by rich grazing grounds and is inhabited. The lake, commonly known as the Lago Grande de Monte-Alegre and celebrated for its fishery of the *pirarucú* (*Sudis grandis*) is situated in the alluvial bottom about midway between Monte-Alegre and Santarem, and to the south-west of the former villa. Sr. Penna says that it is about twenty-five miles long, and from three to five in width. It is most probably an old channel of the Amazonas. The same author states that the lake empties by two channels which soon unite in one called the *Cururuhy'*.‡ This presently receives on the left the Igarapé-apára,§ when the stream takes the name Curupatúba. The course of the latter is at first north or north-east, but, just before reaching the villa of Monte-Alegre, it makes a bend to the east, and, hugging the higher lands on the northern side of the valley, empties into the Amazonas, a few miles east of Monte-Alegre, just below which town, it communicates with the main river by a navigable *paraná-merím*.‖ It is interesting to observe that the Amazonas runs obliquely across the valley, in a north-easterly direction, from the highlands, a few miles east of Santarem, to those of Monte-Alegre, leaving a very broad strip of alluvial campos on the northern side, which narrows towards the east, running out near the

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then corresponds to Rio de Monte-Alegre, which one sometimes hears used. On some maps we find the spelling, Gurupatúba. Gurupá, the name of a little town a few hours east of the mouth of the Xingú, is a corruption of *Kurupá*.

* A Região occidental da Prov. do Pará, p. 125.

† From the reports of the vaqueiros and some fragments of a fine sharp sandstone I have seen, I am led to believe that the geology of the river would prove interesting.

‡ Toad river, from *Kururú*, a toad, and *ỹ'g*, water or river.

§ *Apára* means crooked.

‖ More properly a *furo* or cross-cut.

mouth of the Curupatúba; these plains having been formed by the growth and fusion of islands in the silting up of the valley.

The villa of Monte-Alegre* is divided into two parts, the upper or principal town, and the lower town or port. The latter is situated on the left bank of the river, while the upper town, distant about a mile to the north, and reached by a steep, weary, sandy ascent, is built on the edge of a high, broad, flattened ridge or plateau, extending northward from the river to the serra of Tauajurí, distant some eighteen miles.†

This ridge, which has a height of five or six hundred feet, more or less, is composed of horizontal beds of clays and sands, of probable Tertiary age, and is, as I suppose, a degraded outlier of the once extensive formation of the Serras de Parú. On top it is very flat, but the surface is gently rounded, descending to the plains, both to the east and west, by gradual slopes, abrupt descents being infrequent, except on the southern side, which, having been encroached upon by the Amazonas, is steep, sometimes precipitous along the base, and gullied by many ravines.

The upper town of Monte-Alegre is composed of some fifty, for the most part shabby, tumble-down houses and vendas, together with a handsome new church and a curious, little, old, barn-like chapel, surrounding an immense, shadeless, sandy, Sahara of a square. The inhabitants are principally of Indian descent, but among the white families there are a few of education and refinement. The town has been ruined by the rubber trade, and is fast going to decay. The people are chiefly engaged in grazing, fishing and trade.

From the villa there is a magnificent view over the Amazonian valley. Below is the Curupatúba, which one may trace far to the south-westward, winding, tree-fringed, over the verdant, grassy, alluvial plain, which, level as the sea and variegated by forest patches and mirror-like lagoons, stretches southward for miles to the turbid flood of the mighty river, while away beyond in the south-west, are

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* Happy mount. The name sounds strangely to the traveler who has enjoyed its delectable nights, the cheerful serenades of its *carapanás* and the moon worship of its numerous canine population!

† I regret very much that I shall be obliged to estimate all the distances given in this paper, and that I can furnish nothing more than a rough sketch-map of the district examined. The region has never been surveyed and mapped, and I have hence labored under a very great disadvantage. All my work on land was done on foot, many days often being spent in a fruitless search for rock exposures.

the white cliffs of Cuçary, and the blue, level highlands of the vicinity of Santarem. Seen from Monte-Alegre, the Amazonas does not resemble a river. It comes mysteriously from the west, stretches a broad, reddish belt across the landscape, and disappears in the east, with a wide water-horizon, as if, an arm of the sea, it opened out to the ocean. When the annual flood comes, all the green campos and clear-water lakes are whelmed beneath the turbid current, and even from the heights of Monte-Alegre, the southern shore is but dimly discernible. No wonder that the Indian fisherman calls it *paraná*, the sea! Looking westward from the village, one sees distinctly the high, rocky, irregularly flat-topped serra of Paitúna, with a curious mushroom-like pillar standing on its southern extremity, and called the mão de pilão, or *Induá ména*. A few miles to the north, is the rugged serra of Ereré, breaking down precipitously towards the north. From the top of the ridge behind the town, the beautiful serra of Tauajuré comes into view, while, to the eastward, lie broad plains and campos, with the level-topped mass of Parauáquára lying low down on the horizon. After this reconnoissance of the region we are to explore, let us descend to the lower town and go by water to Ereré.

The descent to the river is at first down a long, sandy incline, showing very few exposures, but the upper part, which is very steep, appears to be composed of reddish, clayey sands, much cut up by rain-courses, the clay being washed out and carried away, while the coarse sand is left lying loose on the surface, supporting a sparse vegetation, consisting mainly of small trees and shrubs, with here and there a giant cactus, cajú trees (*Anacardium occidentale*) being abundant, as we shall find them elsewhere on similar ground. Following the sandy path, and directing our steps to the ravine leading to the lower town, we presently reach a sort of terrace that runs out into a high, bluff, projecting point, extending to the river side just west of the village. This point is formed by a heavy bed of more or less sandy, and variegated feldspathic clay, which, tougher than the overlying beds, has resisted denudation. A little stream of water issuing from above the clay, falls into a ravine, that extends down to the river, and in a steep bank by the side of the road near where the inhabitants resort for water, the clays are well exposed. They vary in character from a pure feldspathic

tabatinga to a clayey sand, and are usually more or less deeply tinted, some of the layers being of a rich, purplish red. This bed of clay appears to be the lowest member of the formation of the ridge of Monte-Alegre. If we descend the ravine cut by the above stream, we presently strike a sloping, fan-shaped deposit of loose, white sand occupying the mouth of the ravine and forming a praia or beach along the river. On this sand, the lower town, consisting of a few houses and stores, is built. It is not a flourishing place; everything speaks of decay, and but little business is done in it. I found the people, however, very hospitable, and Senhor Onetti and his partner did everything in their power to aid me. In Mr. Rathbun's paper, annexed, I shall have an opportunity of recognizing the kindness of Sr. Valente, of the upper town.

Ascending the Curupatúba in a montaria, we find the stream to have a width of 400–500 feet,* and a depth during the dry season of 7–8 fathoms, the current of course varying with the season.

The bluffs, 60–100 feet in height, and covered with woods undergrown with curuá palms, continue for a short distance above the town, where they cease, and the highlands trend away from the river. The southern side of the ridge is high, abrupt, and with a steep slope. In the valley of Surubijú,† just west of the town, are swampy grounds, supporting a luxuriant forest with miriti ‡ (*Mauritia flexuosa*) and assaí § palms (*Euterpe oleracea*), but the vegetation of the sandy slope is very meagre. In the valley is an isolated hill, on which beds of a white, sandy tabatinga are exposed, and near by, were obtained the irregular, concretionary masses of iron-stone, used in building the new church in the upper village.

On the opposite side of the Curupatúba are the alluvial campos of the river-bottom, covered with coarse grasses and bordered along the water's edge by a thin line of trees. We soon leave the Curupatúba, which bends round to the south-westward, and enter the igarapé de Paitúna, a little river, that flows eastward past the

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* 260 metres, Penna.

† Von Martius derives this name from *Sorubim* (*Platystoma*, a genus of fishes) and *y'g*, water, or river. Glossarios, p. 475.

‡ *Ŷmyrá*, tree, *eté*, true. *Ŷmyrá* was originally *ymbyrá*, whence the form *buriti* (Port) used in Eastern Brazil.

§ *Uasai*, lingoa geral, very likely from *yuá*, fruit, and *sé* or *seé*, sweet.

serra of the same name, and which, like all the streams of the alluvial bottom of the Amazonas, has a deep, narrow channel, with very steep, muddy banks. In the dry season, the water of the igarapé is almost stagnant, simply rising and falling with the tide, and the stream literally swarms with alligators of large size. Porpoises gambol in its waters, and its banks abound in game, uacará and mauarí cranes, piasócas, corta-agoas, alencórnos and other birds being exceedingly common. Capibáras are also very abundant in the vicinity.

After following the Paitúna for some distance, we turn off northward into a still smaller stream, called the igarapé de Ereré, and now enter a sort of alluvial bay, bounded by the Monte-Alegre plateau on one side, and on the other by the serra of Paitúna and the swelling sandy highlands stretching thence to, and east of, the serra of Ereré.

The little igarapé is exceedingly tortuous, bending hither and thither in a manner most bewildering to the voyager. Its banks are in part open river bottom, in part margined by a thin line of small trees, palms, as Prof. Agassiz has already remarked, being rare. The water of the stream is very turbid during the dry season, and the narrow channel is often interrupted by floating balsas of *cannarána*. As one ascends the igarapé the valley grows narrower, and at the cattle-fazenda of Sta. Maria, the higher lands of this Ereré plateau come down to the stream, and, in a bluff, obliquely laminated beds of tinted sands and clays are exposed, The alluvial campos of the lower course of the igarapé de Ereré and of the vicinity of Monte-Alegre, are used during the dry season as a pasturage for cattle, and there are several *currães* along the route we have just followed. Cattle raising is indeed the chief branch of industry followed in this part of the Amazonas. The lands in the Ereré—Monte-Alegre district—are for the most part unfit for cultivation, and agriculture is practiced on a very small scale. The proprietor of the fazenda of Sta. Maria informed me that the saúba ant (*Oecodoma*) was so very abundant on his farm that it was next to impossible to raise a crop. It was even necessary to place the house plants upon a staging erected over the igarapé to protect them, and there they were not always safe.

On the left bank of the stream, above the fazenda, begins a very extensive and beautiful grove of *miriti* palms, which occupies a marshy tract, that seems to be quite dry during several months of the year. A little farther on we meet with higher lands on the left bank, and on the same side, between the upper and lower ports of the village of Ereré, there is a narrow ridge of sandstone, rising about twenty feet above the general level of the campos, and which runs off eastward, perpendicular to the river. This ridge is very much broken, the sandstone lying in huge masses, overgrown with trees and spiny shrubbery, so that I found it very difficult to examine it, and I could not satisfactorily determine the direction of the strata. The rock is, for the most part, a very hard sandstone with a clayey cement, but some of the beds are very argillaceous and beautifully striped with brilliant colors.

We have now emerged from a sort of pass between the Ereré and Monte-Alegre highlands, and have entered a vast, low plain, surrounded by hills and high ground on all sides. From north to south this plain probably measures not less than fifteen miles, while its width from east to west must be over ten miles. It lies a little higher than the alluvial plains of the Amazonas, and is drained by the igarapé by which we have just ascended. It is composed of nearly horizontal strata of Devonian age, through which the igarapé has cut a little valley, now partially filled in with alluvial deposits, lying at a lower level than the plain, the Devonian strata forming low bluffs bordering them. The valley narrows to the northward, and, in the upper part, the igarapé flows directly through, and over the Devonian rocks, a clear water stream.

In a little bluff by the side of the road leading from the igarapé to Ereré, and just as one ascends from the alluvial flat, there is an exposure of about fifteen feet in thickness of the Devonian beds. The lower part of the bluff is composed of soft, well-laminated, fine-grained shale, dark gray in color, alternating with white or red layers, and consisting of a fine, more or less sandy silt, with an abundance of little flakes of mica. This locality was discovered in 1870 by my assistants, Messrs. T. B. Comstock, Herbert Smith, and Phineas Staunton, who collected from the variegated shales a pretty little *Discina*, with which are associated two species of *Lingula*.

The only other fossils yet found in the shales consist of obscure, flattened casts, probably of some marine plant, together with a number of minute, discoid bodies, sometimes arranged in little chains, but of which I can make nothing.

Above the shales, just described, is a heavy bed of a not well laminated clay-rock, white, mottled with red, in which I have found nothing except some very obscure fucoid-like markings. All these beds have a very slight inclination to the south-eastward. Going northward, the bluffs gradually increase in elevation, but are probably nowhere more than fifty feet in height. The inclination of the beds of the Ereré plain is quite variable, and, over large areas on both sides of the igarapé, they are almost perfectly horizontal, often forming open campos of large extent, which are sometimes so exceedingly stony as to appear as if macadamized, the soil not being sufficient to support even a growth of grass.

The lowest beds of the series, that I have examined, are exposed in the north-western part of the campo at the cachoeirinhas of Paricá* and Cumamirí† situated on branches of the igarapé de Ereré. At the former locality the rock varies from a very hard, dark-colored, silicious shale, to a well bedded, dark gray, compact, cherty rock, breaking with a conchoidal fracture. The strike of these beds, taken along a water-line, is N. 10–15° W., the dip being westward and exceedingly slight. Leaving this locality and going eastward, the surface of the plain rises noticeably for about a mile, the dip being towards the west, continuing with but few elevations to the cachoeirinha do Igarapé do Cumamirí, where similar cherty rocks, with the same very slight westward dip, are seen in the bed of the stream, forming, during the dry season, a little cascade, which at the time of my visit was not more than two feet in height. The cherty beds have afforded no fossils, except a few fragments found in the more shaly portions.

Between the cachoeirinhas, above named, the beds are traversed by two dykes, which crop out, much decomposed on the surface; one forming a low ridge running nearly north–south, while the direction of the other is nearly east–west. On the right bank of the igarapé de Ereré, and some distance above the trail to Monte-

* A tree, furnishing a seed out of which the Indians make snuff.

† This appears to mean Little Milk.

Alegre, a sulphur-spring bubbles up through the Devonian shales. The water is limpid, of a greenish tinge, and with a strong sulphureous odor and taste; notwithstanding which, the basin in which the water collects is inhabited by little fishes and a species of *Ampullaria*. I regret that I failed in an attempt to bring away some of the water for analysis, especially since at Monte-Alegre it has considerable repute for its medicinal qualities.

Going eastward from the igarapé along the Monte-Alegre trail, one rises by an ascent of a few feet from the alluvial flat to the Devonian plain, that, almost as level as a floor, stretches to the foot of the Monte-Alegre highlands, beneath which the Palaeozoic beds disappear. The surface is quite destitute of soil and is strewn with little nodules of iron-stone, so that large areas are quite barren both of wood and herbage.

Just before reaching the Monte-Alegre highlands, several slight elevations, only a few feet high, are met with, that show, in place, light-colored shales, with thin bands of a reddish sandstone, some of which are full of fossils, *Streptorhynchus Agassizii, nob.*, being especially abundant. At this locality I obtained a single glabella of what appears to be a new species of *Homalonotus*.

If we now retrace our steps to the igarapé, and follow the path to the village of Ereré, we shall find the Devonian beds forming a flat or rolling, open campo, with long, gentle ascents and descents, in the rain-courses of which are indifferent exposures of whitish shales, apparently nonfossiliferous. On this campos-land there is very little soil, what there is being baked hard and strewn with small, angular fragments of red sandstone, that occasionally furnish fossils. The surface is often covered with little, rounded iron-stone nodules, scarcely larger than beans, sometimes forming a continuous layer. The campo is sparingly clothed with coarse grass, trees being few, scattered, stunted and disfigured by campos fires. Occasional large, arborescent cactuses heighten the dry, barren appearance of the landscape. The low places are covered with woods densely filled in, on the drier grounds, with *Curuá* palms.

Between the igarapé and the village of Ereré are several large dykes that project above the surface like ruined walls, but the vein-rock is always badly decomposed, so that it is difficult to say what it originally was. Similar dykes occur in all parts of the plain.

The strata, for a few feet on each side of a dyke, are usually considerably altered, being hard and flinty, while at the same time they are tilted upward at a more or less strong angle, as if the rent had been widened, not by a horizontal movement of the beds, but by the bending upwards of the strata on both sides of the fissure, through the force of the extruding matter. Sometimes in the denudation of the surface, these dykes, as just remarked, project like ruined walls, while at others, with the hardened strata on each side, they form low ridges, that run, sometimes for long distances, on the surface of the campo.

In the village and immediate vicinity, there are no good rock exposures. The most interesting locality, and by far the best collecting ground for fossils, lies at a distance of about two miles to the northward, in a large, open, treeless, grassy campo. The surface here is quite undulating, and strewn with angular fragments of a red or whitish sandstone, rarely ever seen in place. In the rain-courses the rock exposed is usually a fine, soft, well laminated, whitish or yellowish shale, usually quite unproductive in fossils. From the yellow shale I have obtained only a large *Lingula*, fragments of *Vitulina pustulosa Hall, nob.*, showing the imprints of the little spines and a single ventral valve of a *Spirifer*. This shale, which I know only in a somewhat decomposed state, is largely made up of minute silicious particles and little mica flakes. It takes excellent casts of fossils, and would probably repay more careful examination, but I was unsuccessful in my search for a good exposure.

The great repository of fossils is the sandstone, which, as on the eastern side of the igarapé de Ereré, appears to form bands, a few inches in thickness, interstratified with the shales in their upper part. On the washing out of the shales by water the sandstone has cracked up and been left lying in fragments on the surface. Fossils were collected from the loose fragments, but, on the summit of a low ridge, to the north of a deserted house, I discovered on my last visit a layer of the sandstone, which, with great labor, Mr. Derby and I succeeded in uncovering; and this yielded us a magnificent lot of fossils. The layer is only about four inches in thickness, but it is completely filled with fossils which are usually in the shape of moulds, the organic matter having been entirely removed. The rock is com-

posed of fine, sharp, quartz-sand, with a slight admixture of clay, and occasionally a tiny, silvery flake of mica. The fragments of sandstone lying on the surface are usually more or less decomposed, and are apt to be stained with iron oxide, which makes them very hard on the outside, while sometimes the surface is covered with a thin layer of the same material. When unaltered the rock appears to be white, or slightly reddish in color.

The fossils most abundant in the sandstone are the Brachiopoda, which are represented by twenty species belonging to the following genera: *Terebratula*, *Vitulina*, *Tropidoleptus*, *Spirifera*, *Crytina* (?) *Retzia*, *Streptorhynchus*, *Chonetes*, *Orthis*, *Rhynchonella*, and *Lingula*, all of which are described in the paper of Mr. Rathbun, annexed. The only other Articulates are the trilobites which are represented by a beautiful *Dalmania* that occurs in abundance, and a species of *Homalonotus*, of which last only a fragment is known.

Several species of Lamellibranchs occur in the sandstone, belonging to *Nuculites*, *Palaeoneilo*, *Grammysia* (?), *Edmondia*, and one or two other genera. The Gasteropods number about eight species, representing the genera *Bellerophon*, *Platyceras*, *Holopea*, *Pleurotomaria* and *Tentaculites*. A few fragments of crinoid stems have been found, together with a number of obscure markings which may be of plants.

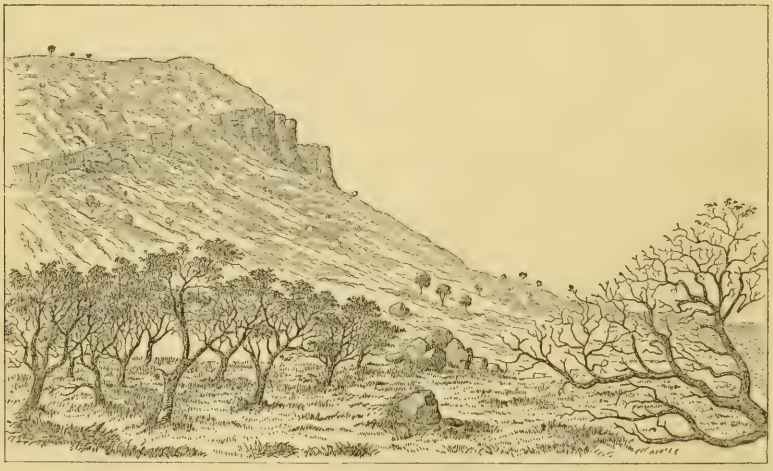
Serra of Ereré from the North.

This fauna has an unmistakable Devonian facies, but it is difficult to determine its exact equivalency. In some features, as for instance in *Spirifer Pedroana*, which closely resembles *S. varicosa*, the fauna recalls that of the Corniferous, while in the occurrence of *Tropidoleptus* and *Vitulina* it approaches the Hamilton.*

* See concluding remarks to Mr. Rathbun's paper.

The serra of Ereré is a high, narrow, rugged, irregular ridge, four or five miles long, trending about east-north-east and west-south-west, and with abrupt and often precipitous sides. The upper part of the serra is formed of very heavy beds of sandstone, that dip to the south-south-east at an angle varying from 5°–20°. The top of the ridge is very irregular, ragged and picturesque, the sandstone being often exposed, in situ, in bare ledges or ridges, or lying strewn about in enormous blocks over the surface, which is so rough that it is no easy task to traverse the mountain from one end to the other. Along the northern side of the serra the sandstone forms a broken line of bluffs, varying in height from a few feet to several hundred; and just opposite the little village, and shown in the cut, there is a splendid precipice, remarkable for being rent by fissures from top to bottom. Below these bluffs the side of the serra slopes very steeply, presenting the appearance of a talus, the surface being covered with loose fragments of sandstone.

At both ends the serra is cut squarely off, but on the east the sandstone extends downwards, with a strong dip, disappearing under the more modern clays and sands of a swelling ridge like that of Monte-Alegre, that stretches eastward to the igarapé, covered with the characteristic vegetation of the high, sandy campos.

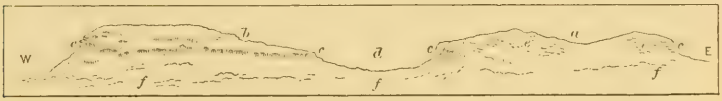


Serra of Ereré from the East.

On the southern side of the serra, and near the eastern end, these sandy campos rise by a gentle incline nearly to the summit, so that

one may ascend the serra on horseback. To the westward of this incline, the sides of the serra are exceedingly rough and picturesque. On this side there is hollowed out of the sandstone a large and curious grotto, called Itá-tupá-óka.* This is situated at some little height above the base of the mountain, and is reached by a steep ascent, encumbered by blocks of sandstone, and overgrown with cacti and stiff bushes. The cavern forms a large, irregular, bat-inhabited chamber 50–60 feet long, and with a sandy floor. Wallace had already described the entrance, which is 10–15 feet high, and divided into two parts by a layer of sandstone that runs horizontally across the opening about five feet from the floor. This layer is harder than the rock above or below, much of which is very friable.

Immediately west of the serra of Ereré, and separated from it by a deep notch, is a short, angular ridge, with the same trend and geological structure, called Aroxí. In this mountain, which is a little lower than Ereré, the inclination of the sandstone is very marked. On the southern side a broad belt of large cactuses extends from top to bottom.



Serras of Ereré and Aroxí from the South-west.

To the westward of Aroxí, at a little distance, is another short, high, conical ridge, called Aracurí, while beyond appear to be several other hills, in a line with those just enumerated, and apparently part of the same outcrop.

The sandy campos decline towards the southward from the serra for several miles, when they rise gradually to the rocky plateau of the serra of Paitúna. This serra I did not visit, but in 1870, Mr. Phineas Staunton examined it for me, reporting it to be composed of horizontal beds of the same kind of sandstone as that of the serra of Ereré, so that the two serras probably form part of a synclinal fold. Paitúna is flattened on top, and very broken and precipitous on all sides. Wallace, who visited it, says that the curious, mushroom-like pillar on the southern end is composed "of friable

* Literally, God's stone house. *Itá*, stone; Tupá, or Tupána, God; and óka, house.

stone in horizontal layers and is constantly decaying away by the action of the weather. The top is formed by a stratum of hard, crystalline rock, which resists the rain and sun," etc. This upper crystalline rock is probably like the excessively hard sand-stone of the serra of Ereré. The pillar bears the name *Induá ména** in Lingoa Geral, or *Mão de pilão* in Portuguese, and, together with another similar column in the vicinity, figures in the legend of the Paitúna, a mythological personage from whom the Indians say that the serra has derived its name.

The sandstone of Ereré is, for the most part, composed of fine, rounded grains of clear quartz, with a silicious cement, the rock being so excessively hard that a fracture passes directly through the sand grains. The rock has a slight brownish tint, and a saccharine look, sometimes being almost translucent in thin flakes. On the surface the cement decomposes, becoming milk white, and the hard beds scale away in concentric coats, giving rise to rounded surfaces. This is the general character of the Ereré sandstone, but there are some very fine-grained layers like quartzite, while others are soft and friable. The rock is never very coarse, and pebbles are rare. The bedding is massive, and oblique lamination is everywhere observable.

Underneath the sandstone at the notch of Aroxí there is a thick band of hardened, variegated clay. Being well jointed and of unequal hardness, the Ereré sandstones, have, under denudation, given rise to a multitude of curious pillars and imitative forms. To the latter class belongs a large rock on the east extremity of the serra, called *Pirayauára*† or porpoise, because of its resemblance to that animal, while near by, on the brink of a precipice, is a projecting, bird-like rock, called *yurutauí*. On the summit of the mountain, and overlooking the lofty precipice facing the village, is an immense, isolated rock, about fifty feet high, which, from afar, looks like a huge boulder perched upon the top of the serra. This mass, which is represented in the cut on page 213, is composed of a very hard, white sandstone, obliquely laminated and rounded by decomposition. Its western side is covered with rude Indian drawings in red paint.

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* Pestle. Sometimes it is called *Induá*, the mortar. *Ména* means husband. By some the pillar is called *yapóna*, the oven.

† *Pirá*, fish, and *yauára*, dog.

Standing just in front of the cliff at the upper part of the serra, on the northern side near the Aroxí notch, is a large, high pillar, covered with similar rude paintings, and apparently at one time an object of superstitious regard. Similar figures are drawn on the cliffs near by and in the notch. These so-called hieroglyphics of Ereré were examined and copied by Wallace, but the sketches were unfortunately lost. I have reproduced some of the more important forms in the *American Naturalist*.* Mr. J. B. Steere, on a visit with me to the mountain, had the good fortune to find a large fragment of silicified wood, imbedded in the sandstone, near the great painted rock on top of the serra. This is clearly coniferous in structure, but Dr. Dawson, to whom it has been referred, has not been able to determine it. Mr. Steere also found what appears to be the impression of the trunk of a large tree on the surface of a bed of sandstone, on a ridge about a quarter of a mile to the southwestward of the painted rock.

One point in the geology of the Ereré District is settled upon the best of palæontological evidence, and that is, the age of the beds forming the great plain to the north of the serra. These are certainly Devonian. But what is the age of the rocks forming the serra itself? I have already expressed the opinion that the strata of the serra were disturbed before the beds forming the plains were laid down, since these strata are highly inclined, while the Devonian rocks bordering the base are quite horizontal, presenting nowhere more than an exceedingly slight inclination. There is no reason why coniferous wood should not occur in strata of Devonian, or even Upper Silurian age under the Equator; but I must freely confess, that, after carefully considering the whole subject, it seems to me quite probable that the Ereré sandstones are really newer than the fossiliferous beds of the plains, and that these last may dip under the serra; but, if this is the case, it is extraordinary that the sandstones, if once continuous over the plains, should have been so completely worn away and that the plains should have been so very evenly denuded. It is also somewhat strange that the structure of the serra of Tajurí should differ so markedly from that of Ereré. I have made a long and careful search for exposures along the base

* Brazilian Rock Inscriptions, Amer. Nat., May, 1871.

of the serra of Ereré, but I have been unable to determine from stratigraphical evidence the relative age of the beds of the mountains and plains. There can be no doubt that the serra of Ereré is older than the true table-topped hills, and the question of its glacial origin needs no further discussion.

In the sandstone of the serra are occasional veins, partly composed of iron oxide. The original vein-rock appears to have been traversed by a perfect network of delicate veinlets of hematite, forming interlacing laminae often not more than one or two millimetres in thickness, which, on the decomposition and removal of the vein-rock, form masses presenting the appearance of honeycombed wood. In 1870, I made barometrical measurements on the summit of Ereré, which gave me the height as 970 feet. Since the observations were taken, I have noticed that a point to the westward of those I had chosen appears considerably higher, so that the serra is not far from 1,000 feet in height.

The vegetation of the serra resembles that of the high, sandy campos of the vicinity, and is very scanty. The sandy tracts are sparsely sown with tufts of long, coarse grass. Trees are as usual very small, rough-barked, gnarly-branched, stunted and scorched by campos fires. Cajú trees grow all over the serra, and the visitor will always gratefully remember their thirst-assuaging, acid fruit. The cajueiros of the serra are all very small, and the fruit is dwarfed and rather sour. On the sandy campos the tree is everywhere met with, and the fruit is sometimes very large and delicious. I have never seen a cajú tree on the Devonian plain. It is a true campos species, and, as elsewhere in Brazil, it appears to be confined to dry, sandy soils. It flourishes also on the campos in the vicinity of Santarem, where, as well as at Monte-Alegre, a very delicious wine is made from its juice, some of the brands being not inferior to good grape wine. The manufacture of this beverage was known to the old Tupís, who called the liquor *akayú kauim*. The fruit has an extended reputation in Brazil for its anti-syphilitic properties, and it is supposed that the wine also possesses medicinal virtues. Two palms are common on the serra, the *Sacurí* and *Jatá*. The former appears to be allied to the Curuá, but the leaves are much more stiff and erect. It is rarely seen elsewhere in the vicinity. The Jatá grows to a height of about fifteen feet, and is a very con-

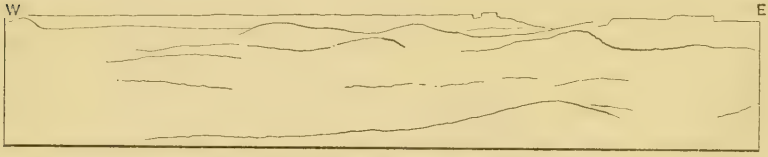
spicuous element in the vegetation of the serra. It also occurs on the campos. Armadillos and jabutí-tortoises abound in the serra, and a pretty little species of deer occurs, but I could never succeed in getting a shot at one.

Before we leave the serra let us take a survey of the landscape. The eye follows the sandy campo, with its scattered trees and patches of bare sand, southward to the flat, insignificant-looking, rocky serra of Paitúna, which, tied by the high campos to the serra of Ereré, forms a point projecting southward into the alluvial bottom of the Amazonas. On the right, or west of Paitúna, the alluvial lands form a sort of bay, bordered by sandy campos-land. Into this region I made an excursion in 1870. From the Aroxí notch the sandy and sparsely-wooded plain slopes gradually from the mountains to the southward, for a few miles, to a little igarapé, called, I believe, Maxirá; but this name I have also heard applied to the serra of Aroxí. Crossing the stream, one finds on the opposite side a line of terraces rising about 10–15 feet, if I rightly remember, above the general level, but considerably more above the Amazonas. These terraces are composed of beds of variegated sands and clays, in which I made an unsuccessful search for fossils. This formation appears to occupy a large area to the westward, and the terraces mark an old shore-line when the land stood at a somewhat lower level than at present, and the Amazonas, still a broad arm of the sea, had not yet passed into the riverine condition. Between the terraces and Paitúna is the alluvial bay just alluded to, in which is a small lake and a magnificent grove of miritís. The lake, I suspect, disappears during the dry months, as I do not find it represented on one of my sketches.

Eastward of the serra of Ereré, a high, rounded, sandy plateau stretches off to the igarapé, on the opposite side of which the Monte-Alegre highlands run off obliquely to the villa, in a line of steep slopes. Between these highlands and Paitúna is the alluvial bay traversed by the igarapé of Ereré. Across its mouth stretches the Curupatúba, and southward lie the beautiful, smiling plains, beyond which is the Amazonas, with the long, level line of smoke of a descending steamer. We trace to the northward the ridge of Monte-Alegre, at first level-topped, then more and more irregular, to the splendid, blue, mountain mass of Tauajurí, which, with pre-

cipitous front, heaves its back against the horizon, like a giant wave ready to break upon the level plains of Ereré, that lie spread out before us, flecked with open, bright, grassy campos, dark woodland, and coursing cloud-shadows from the glorious sky above. Below us, and beyond a little strip of woodland, is the little village of Ereré, with its white church and scattered, thatched houses.

In the west are the tops of Aroxí and Aracurí, with low lands beyond on the horizon, while, northward from the hills, stretches a belt of low, wooded ridges, skirting the campos on the west and north, and bending round to close the circuit with Tauajurí. And away beyond them, on the far-off northern horizon, are table-topped hills, evidently of the same formation as the serras of Parú. To give a clearer idea of the topographical features of the highlands west of the campos and of the distant table-topped hills, I have introduced the following little outline sketch taken without alteration from my note-book.



Sketch looking Northward from Serra of Ereré.

A mile or more west of the village, a very narrow, angular ridge extends northward from the northern side of the serra of Ereré, in a straight line for perhaps a mile, presenting a very even height of about 200 feet, as nearly as I could judge. On the eastern side this ridge is very steep, and near the top there is a line of exposures of a rather compact, not well laminated clay-rock, mottled red and white, and apparently without fossils. This has a decided dip to the westward, and the western slope of the ridge is consequently less steep than the eastern. The ridge is unfortunately covered with small trees, abominable "Devil's fish-hooks" and cactuses, so that it is very difficult to study it. After running along for a considerable distance, it breaks down abruptly, or perhaps more properly speaking, it is cut through by a broad gap, through which runs the road to Maccurú.

In the gap, the lower part of the ridge to a considerable height, is seen to be composed of a heavy mass of diorite; but whether this

rock forms a dyke, or a bed interstratified with the clay-rock, I could not determine. In the rain-courses of the Maecurú road the diorite has given rise to a great number of well-rounded boulders of decomposition, imbedded in a dark soil of decomposed trap; and, at a hasty glance, they might be taken for erratics. On the northern side of the gap the ridge appears to be continued for some distance. Looking from the top of Ereré there appears to be a ridge running northward from the Serra de Aroxí like that just described. I made an attempt to reach it, but lost myself in the thick woods. An attempt to explore the zone of highlands to the west of the campos proved very unsatisfactory. I made a very long excursion among these hills, but I cannot give an intelligible account of their structure, because of the want of exposures and the difficulty of making and recording observations in the dense undergrowth, and in the beds of the exceedingly tortuous igarapés. The prevailing rock appears to be similar to that exposed in the ridge extending northward from Ereré, but I found also a few wretched exposures of a firmly laminated, dead-black shale without fossils. I know nothing of the relation borne by these beds to the undoubted Devonian beds of the plains. Trap dykes are very numerous, and some are very heavy. The whole region seems to have been much disturbed. At Matarupí and elsewhere in the vicinity there are superficial deposits of impure haematitic iron ore. Campos, apparently composed of Devonian rock, extend from the ridge running north from the serra of Ereré to the serra of Aroxí.

Almost directly north of Monte-Alegre is an isolated, precipitous hill several hundred feet in height, which, in company with Messrs. Smith and Staunton and my guide Sr. Liberato, I tried to reach from the campo on the southern side. All I was able to do was to climb a sort of high platform, in front of the hill, which was so covered with spiny plants, *yurupari pindá* and underbrush, that I was obliged to turn back. I should have persisted, but that I had several hours' march before me over the stony plain to Ereré that evening. I could only determine that the platform above spoken of was composed of diorite like that of the ridge just west of Ereré.

The little hamlet of Ereré is situated on the Devonian plain, a little more than a mile to the north of the eastern extremity of the

serra of Ereré, and consists of some twenty to thirty miserable thatched houses and a neat little chapel. The inhabitants are civilized Indians, of more or less mixed blood, but it is not known from what tribe or tribes they are descended. The old people still speak the Tupí language, but it is becoming so rapidly superseded by the Portuguese that it is only rarely used for conversational purposes. The people are quiet, orderly, and clean, and I came to have a real respect for them. Sr. Liberato, my host, is a fine, intelligent, trustworthy fellow, to whom I am under deep obligations for the faithful way in which he served me on both visits to Ereré, and I take pleasure in recommending him as a guide to future visitors. The men of Ereré are fishers, hunters, vaqueiros, and, like other Indians, work well when they must. Of the industry of the women I cannot speak in too high praise. On them falls all the labor of the field and household; from morning to night they are steadily at work, and I never think of Ereré without fancying that I still hear the measured rhythmic beat of the caraná wand, in beating cotton for spinning.

The sandy ridge or plateau east of Ereré shows but few superficial, and not very interesting exposures. Like the Monte-Alegre highlands, it appears to consist of soft Tertiary beds, horizontally stratified, which have been much denuded down and superficially worked over, the clayey particles having been washed out, leaving the sand lying loose on the surface. On the northern side of the ridge, at some distance east of the serra, is a small, isolated hill composed of fine clayey sands, white, variegated with purple, together with white sands, sufficiently compacted to form a low bluff, that runs round the eastern side of the hill. The ridge behind is composed of the same materials, as is seen in several deep rain-courses. On the hill just described, and in its immediate vicinity, I picked up several loose fragments of a very curious rock which I was unable to find in place. It consists of iron-oxide and is filled with little, empty cell-like cavities separated by very thin walls, and consequently spongy and very light. Each cavity corresponds to a sand-grain which has been dissolved out, leaving only the iron oxide that cemented the whole together. The grains were probably calcareous, but I have no clue to the origin of these very interesting fragments.

The serra of Tauajurí,* though in plain sight from Ereré and from the vicinity of Monte-Alegre, is quite unknown to the white inhabitants of these places, and I found none except Indians who had visited it. Failing to reach the mountain in 1870, I made an excursion thither the following year, in company with Messrs. Derby and J. B. Steere. We left Monte-Alegre on foot at day-break, accompanied by four Indians, striking off northward over the highlands, following the road to Saudoso, a little agricultural settlement, situated on the low grounds east of the ridge.

The Monte-Alegre plateau is noted for its flat, rounded outlines, its long, gentle slopes, rarely gullied by rains, its superficial coating of coarse sand, and its peculiar campos vegetation, in all which features it agrees with the similar elevated, sandy campos of the vicinity of Ereré and Paitúna, and also with those of Santarem, which last I shall not attempt to describe here. The covering of loose, coarse sand completely masks the geological structure of the plateau, except along its southern border and in a few localities where the underlying beds come to the surface in knolls. Here and there on the road, across the plateau, from Ereré to Monte-Alegre, one meets with slight knolls composed of small, ferruginous concretions, cemented together and resembling a conglomerate. The surface sands are so coarse and loose that it is very fatiguing to walk over them. The vegetation they support to-day is that of the high, sandy campos districts everywhere in northern Brazil, modified by campos fires. The sandy campos of the Ereré–Monte-Alegre district closely resemble those of Piauhy, Pernambuco and Bahia. Trees are sparsely sown, and, having been singed by fire, are small, rough-barked, stout and gnarly-branched, and thick-leaved. A large proportion of the trees are cajús, with whose grateful acid fruit the traveler may refresh himself. Grass grows only in widely separated tufts, and the surface is yearly burned over. The effect of these campos fires is most disastrous, and if kept up they must inevitably convert the ridge into a desert.

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*I am not sure that this is the correct form of the name of the serra. The pronunciation varies from *Tajurí* to *Tayurí*, *Tauayurí*, *Tauajurí*, and I have even heard *Tauacurí*. Penna uses *Tauajury*, and this appears more nearly right, but it would still be a Portuguese form. In all this uncertainty it seems scarcely worth while to inquire into the origin of the name. The first point to be settled is, whether the first part of the word, in lingoa geral, is *itá*, stone, or *tauá*, a kind of clay.

The Monte-Alegre campos are quite unfit for agricultural purposes, but according to Sr. Valente, who accompanied us for a part of the way to Tauajurí, beans and even corn may be grown during the wet months; but mandioca cannot be raised on these lands, because it requires at least six months to mature, and, during the rains, the roots are apt to be washed out of the soil. The climate of the Ereré-Monte-Alegre district, during the dry season, is very pleasant. Day after day, and week after week passes without a storm. The days are hot, the thermometer in the shade ranging about 90° in the middle of the day; but the air is so dry and there is so constantly a stiff sea breeze blowing, that the temperature in-doors is very agreeable. On the plains, I have found the heat oppressive while in exercise, though much more endurable than in the interior of New York in the summer months; but the moment one stands still, even on the open plains, he is apt to be chilled by the breeze. The nights are very cool, and one is obliged to sleep wrapped in a blanket and with closed doors. Late in the dry season and in the rainy months, the mosquitoes are a veritable plague. Of the wet season on the Amazonas I can say nothing from my own personal acquaintance.

As the plateau approaches Tauajurí it becomes more broken, and better wooded, but it soon gives way to hills, probably of a different geological structure. The lowlands east of the ridge are well wooded, but, except in marshy places, the forest is not luxuriant, and the same seems to be the case with the higher plains of the vicinity.

We reached Jacaré at the foot of the serra at 3 o'clock P. M., having rested for dinner at Saudoso for perhaps a couple of hours, so that the distance from Monte-Alegre to the base of the mountain must be about 18 miles. At Jacaré we found a ruined house, and as we had outwalked our guides and were obliged to wait until late in the afternoon for them to come up, we here spent the night, as well as the carapanás and the white ants, that swarmed from the rotten timbers of the house, would permit.

On the banks of a little, clear-water igarapé that runs through the forest, bordered by beautiful palms, we found sandstones, and I discovered a bed of dark-bluish limestone, that looked as though it ought to contain fossils, but afforded us nothing recognizable. Its strike was N. S., and the dip 30° to the eastward.

Early the next morning we climbed the serra by a very rough, steep ascent through the woods over loose rocks, and worked our way with much difficulty nearly to the western end of the mountain. The serra is a sharp-crested monoclinal ridge, trending approximately E. S. E., W. N. W., and much longer than Ereré. The southern side is exceedingly steep, almost precipitous, and wooded nearly to the top, along which runs a line of low bluffs. The northern side slopes off at an angle of 10°–15° in a series of beautiful campos interspersed here and there with trees. This side of the serra is scored deeply with deep parallel gorges that extend in many cases up to and through the crest of the serra, which consequently presents a notched appearance when seen from the south.

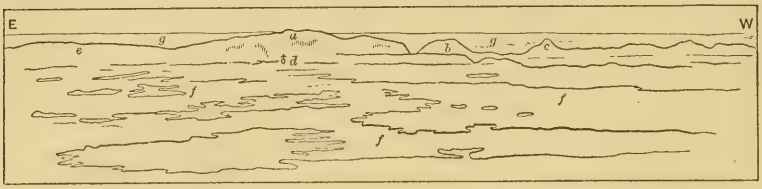
The uppermost stratum observed near the crest of the serra was a light bluish, nearly white, tough, not well laminated clay-rock, with a large percentage of very fine sand in its composition. Beneath this are beds of fine, clayey sandstone, white, mottled with purplish, and with fucoid (?) casts, alternating with which beds are shaley bands and layers of sandstone, the whole not well exposed. Then follow about 4 inches of red shaley iron-stone, overlying a bed of rather coarse sandstone about 10–15 feet in thickness, which forms a bluff running along the upper part of the southern side of the serra, while underneath are light purplish brown, fine-grained sandstones poorly exposed. The dip of the Tauajurí beds in the serra is about 10°–15° towards the N. N. E. or N. E.

I found the elevation of the serra at its highest point to be 850 feet above the level of the sea.* Tauajurí appears to differ entirely from Ereré in its geological structure. It is, indeed, true that I examined only the upper beds of the series, but if the Ereré sandstone were represented lower down, it is hardly possible that it should not have shown itself in bluffs on the mountain side.†

* I made but a single observation, and as the mountain looks much higher than Ereré, I suspect that the observation may be unreliable.

† Tuajurí is resorted to by the Indians of Monte-Alegre for the purpose of gathering the bark of the cumaté or cumatí tree (*Apocynea vel Asclepidea follicularis? v. Mart.* Glossarios, p. 393, sub voce *cumatí*), the sap extracted from which is used to varnish the drinking gourds, for the manufacture of which Monte-Alegre has been so long famed. The name of the tree appears to be derived from *kamŷ'g*, milk, sap, and *eté*, true. *Cumaté* probably more nearly preserves the original form than *cumatí*, but I suspect it is still a corrupt form. The sap is obtained from the bark, I believe, by pounding and squeezing. The cuias are prepared as follows: The

From the summit there is a magnificent view over an immense area of country, the whole Monte-Alegre–Ereré highlands and the great Devonian plain being distinctly seen. I have reproduced from my note-book a little sketch of the Ereré hills taken from the top of Tauajurí, because it shows a line of hills extending westward beyond Aracurí, apparently forming parts of the same outcrop.



The Devonian plain and serras of Ereré from the Serra of Tauajurí.

To the northward of the zone of highlands bordering the Ereré plain on the north and west, the country is low, somewhat irregular, though with but few hills, and uniformly covered with forest. Along the horizon, on the north-west, high, table-topped hills stretch along for many miles like a cordilheira. To the east of Tauajurí the country is low, but still considerably higher than the Amazonian bottom. Just east of the Monte-Alegre highlands these higher grounds do not come down to the river, but their margin, once an old shore-line, describes a strong curve forming a sort of bay which has been silted up and converted into alluvial grassy campos, while, skirting the old shore, is a long, narrow, crescent-shaped lake, once a side-channel of the river. This alluvial bay and lake put one in mind of the campos and paraná-meríns of Taperinha, of which I hope to speak in another paper.

From what I have seen of the Amazonian valley in the province of Pará, I am of the opinion that the greater part of the country

gourd, or fruit of the *Crescentia Cuyeté* (kuiá-eté=*cuia par excellence*) is cut in two and the inside pulp removed. When the rind is dry it is carefully scraped, both inside and out, and polished with the sandpaper-like leaves of the caimbé tree (*Curatella*). A little charcoal of the wood of the páo de Boia or Mututí is then scraped into the cuia, and, having been mixed with a few drops of the cumaté, is rubbed over the surface of the vessel. Over this the cumaté is applied three or more times, and on being allowed to dry, forms a sort of purplish varnish. The cuias are then inverted over sand on which stale urine has been sprinkled, but some persons fill them with the urine and allow them to stand. The cumaté varnish, probably affected by ammonia fumes, soon turns jet black and forms a hard, brilliant, durable lacquer, not affected by hot water or rum. The cuias of Monte-Alegre are often painted in color, with very tasty and often elaborate designs, by the Indian women.

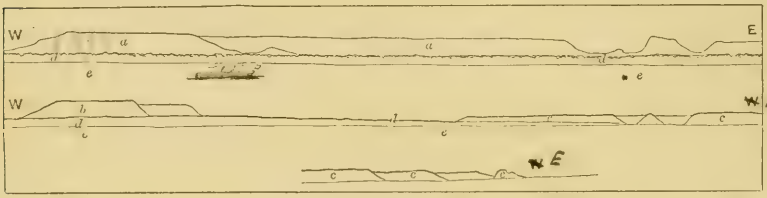
is covered with forest, and that open campos are the exception. These last are confined either to the very low lands inundated during the wet season, but left dry several months in the year without rain, or to the high, level, never inundated sandy grounds and the hard-baked, clayey or stony plains of Ereré. The alluvial, bottom of the Amazonas in the vicinity of Monte-Alegre and elsewhere, is, over very large areas, destitute of trees. My friend Dr. Woiekof, the Russian savant, is of the opinion that the treelessness of prairies is often due to the rank growth of grasses. I am inclined to think that this is in great part the cause of the want of trees on the Amazonas river-bottom; but there is still another reason, and that is the dryness of the climate, and the baking of the alluvial clayey soil in the dry months. The forest gains a foothold only on the borders of the streams and in wet places, where it holds its own by its proximity to the water.

The only really tropically luxuriant, true jungle is found on perennially wet grounds. This is always full of palms, *Phœnacospermums*, *Heliconias*, *Arums*, large-leaved plants, and is tangled with vines and creepers. The vegetation of the higher and drier grounds is not very luxuriant, especially if the land be stony, sandy, or clayey. Such is the character of the forests of the higher lands everywhere in the vicinity of Monte-Alegre and Ereré. The trees are, for the most part small, and the undergrowth is largely composed of *curuá* palms.

Even where the land is high, if the soil is only damp and rich, the forests may be exceedingly luxuriant and composed of trees of giant size, as for instance on the black lands on the top of the bluffs near Santarem, and on the high lands of the Tapajos, Tocantins and Xingú.

The generally received opinion that the whole valley of the Amazonas is covered with one dense, rank, steaming forest, impenetrable and indomitable by man, is as erroneous as the school geography stories of enormous snakes and wild beasts, which last, somehow or other, were always hibernating when I was in the country. The forests of the Monte-Alegre–Ereré district and of Santarem as well, are far from luxuriant, bespeaking, during the dry season, a very dry climate and a fault of moisture.

The table-topped hills of the Amazonas, so frequently described by travelers consist of several isolated mountains or plateaus of circumdenudation composed of horizontal strata, which lie on the northern side of the river between Prainha and Almeirim, and known collectively as the serras of Parú. They are characterized by their broad level tops and their very abrupt, sometimes precipitous sides. The western-most of these serras is that of Parauáquará, eastward of which is that of Velha Pobre, while still farther east are the serras of Almeirim. The general appearance of these mountains is represented in the accompanying sketch made from the river.



Every traveler has felt it his duty to describe the table-topped hills, and they have been represented, over and over again, by fancy sketches that look no more like the serras of Parú* than they do like any other flat-topped hills, but, strange to say, until 1871, no explorer except v. Martius has ever visited them. He landed at Almeirim on his journey down the Amazonas and climbed the serra in the immediate vicinity, which he estimated as scarcely 800 feet in height. He, however says very little concerning its geological structure, but his account of his visit is so important that I give a part of it below.†

*I cannot refrain from protesting against the admirably drawn but abominably inaccurate sketches that illustrate the magnificent volumes of Marcoy. The sketches of Santarem and Pará might just as well have been labeled Pernambuco and Bahia. As for the portraits that adorn the volume they are, so far as I can judge, as inaccurate as they well can be.

†"Der Berg von *Almeirim* liegt etwa eine Stunde nördlich vom Ufer des Stroms entfernt, und sein Gipfel mag kaum acht hundert Fuss über diesen erhöht seyn. Wir hatten bald einen dichten nicht hohen Wald durchschnitten, und tratten nun in eine lichte Grasflur heraus, welche in ihrer Physiognomie die grösste Achnlichkeit mit den campos agrestes von Piauhy darstellte. Grosse, grau-grüne, haarige Grasbürchel, mit mancherlei blüthenreichen Kräutern wechselnd, stehen ziemlich weit aus aufgelösten braunen Sandeisenstein. In den Niederungen der Flur sind hier Brüche von geringer Ausdehnung, ebenfalls mit Gras bedeckt, dort inselartige gruppen von Gebüsche und eine eigenthümliche Palme (Lyagous cocoides, Mart. Palm, t. 89-90). * * * * Der Berg selbst, welcher diese anmuthige Landschaft schliesst, indem er parallel mit dem Strome von O. nach W. läuft, ist an seinem untern Abhange mit gleicher wiesen vegeta-

In 1870 my time was so completely exhausted at Ereré, that I was obliged to return home without visiting the table-topped hills, and one great object of my journey to the Amazonas in 1871, was the examination of one of the true table-topped hills. I selected Parauáquára, not only because it appeared to be the highest of these mountains, but also because, being precipitous, it would be the more likely to afford good sections.

I left Praïnha very early on the morning of the 14th of November, in a montaria, and dropped down with the current nearly to the mouth of the Rio Yauarí* (Javarí). During the night and to 7½ o'clock the terral blew gently down stream, and it was deliciously cool; after that time the wind gradually lulled, the sea breeze beginning to blow at about 9½ o'clock. This continues to blow all day regularly during the dry season.

The Yauarí has a sort of miniature delta. Just before entering the Amazonas the river bends eastward, separated from the river by a grass-covered strip of alluvium, across which two channels are cut. It was low tide when we arrived at the mouth of the river, and we were obliged to wait for sometime before we could enter. The Yauarí resembles the igarapé de Ereré in having a very deep, narrow channel, about 200 feet wide, with steep banks lined with trees which are, however, larger than those of Ereré, while the banks are cleaner. The vegetation is largely made up of the following trees: *Mututí*, *Acapú-rána* † (*Wullschlägelia?*), *Araparí*, ‡ *Caxingúba* § (*Pharmacosycea?*), *Piranhaúba*, ‖ *Taixí* ¶ *and Uapuí*.[1]

During the dry season the water of the river and its branches is quite stagnant, excessively dirty, warm and fever breeding, its

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tion, oben aber mit einem lichten Walde grosser Bäume, besonders vieler castanheiros, bewachsen, auf dem steilen Wege findet man nirgends ein anderes als das angegebene sandeisensteingebilde. Kleine Quellen kommen aus den Flanken des Berges auf die Wiesen herab, und die Waldung der Höhe hegt behagliche kühle."—*Spies u. Mart. Reise in Brasilien, IIter Theil, S.* 1326.

* *Yauarí* is the name of the palm *Astrocaryum javary*. The Portuguese form is Javarí.

† Called also manupé, or the yauarí. v. Martius gives the following etymology: "*Caa-cua: acapoc:* arbor fructu desiliente; *rana:* spurium," which strikes me as very fanciful.

‡ This may be a corruption of *ymyrá-apára-y'ua*, meaning bow-tree.

§ *Kaá xingy'ua*, Lingoa geral.

‖ *Piráña-y'ua*, Lingoa geral, tree of the cannibal fish.

¶ *Taixí-y'ua*, tree of the ant *taixí*, so called because its hollow leaf-stalks are inhabited by a very venomous ant. Taixí appears to be derived from *tasy'ua*, an ant, and *i*, little.

[1] *Y'ua-puí*, slender tree.

only motion appearing to be that induced by the tides. Alligators swarm in it like tadpoles in a ditch, and I was not a little surprised to find them extraordinarily active, swimming rapidly about and coming up promptly to snap at an object thrown into the water. The banks of the river are alluvial, and go deeply under water during the rainy season.

After ascending the Yauarí for some distance we turned off northeastward into a smaller stream called the Marapí, on the left bank of which, not far from the mouth, is the cattle fazenda of Leocadio José Rodrigues, at which I was most hospitably entertained. This fazenda is built on a little knoll, surrounded on all sides by alluvial plains, which are partly open and covered with grass, the rest being forested.

The serra of Parauaquára is distant, as nearly as I can judge, about twenty miles to the eastward of the fazenda, and in plain sight, but I could find no one who had visited it, and it was even an object of superstitious fear, like the serra of Velha Pobre, which is to-day held to be haunted by a female spirit, to appease which boatmen hang offerings of rags and clothing upon the trees on the banks of the Amazonas at certain localities. I had some difficulty in obtaining guides for the journey, but Sr. Leocadio kindly furnished me with a negro and a mulatto, and my party was completed by three young Indians I had brought with me from Praïnha. We set out on foot with provisions and water for three days, for we were warned beforehand that we should find no streams on the route.

For two or three miles eastward from the fazenda our way was through wooded and marshy campos, until we reached a broad, level, open plain, used as a grazing-ground for cattle, in crossing which we were completely covered with myriads of minute carapáto ticks (Ixodes), from which we with difficulty rid ourselves, an episode that brought up vivid reminiscences and no *saudades* of the campos-land of Minos Geraes. The open plains, just described, are represented in Plate VII. by the irregular lake-like patch, near the Amazonas. From the grazing-grounds to Parauaquára, the country, though not high, is very rough, the topography appearing to have resulted from the denudation of soft beds, interstratified with which, are thin strata of hard, brown, ferruginous sandstone, blocks of which encumber the ground. A heavy fruit-growth, with jungles of the magnificent banana-like *pacúa-sor-*

oróca (*Phaenacospermum*) fills the wet valleys, but the higher grounds are a mixture, or more properly an alternation of campo and wood, the campos being thickly covered with high grass and scattered trees, while the woods are thick and dry. One tree in these woods especially attracted my attention. Only a few inches in diameter it grew like a giant withe, straight up above all the other trees, destitute of branches except at the top, where were only a few short ramifications. The Indians call it *kuatá kysáua*, or the hammock of the cuatá monkey.

The journey was exceedingly fatiguing, and in the woods we were obliged to use our knives incessantly, but what made our progress most painful, were the high grass and bushes filled with cariá, a long-leafed sword-grass that cuts like a razor. My heavy duck trowsers were soon cut out at the knees, and my hands and face were cut and bleeding, while the bare feet of my attendants suffered severely. Approaching the serra the topography became more and more irregular, and, just before reaching the mountain, we descended into a deep valley, through which flows a stream of delicious water, passing which we rose to a sort of isolated shelf at the base of the serra, where we passed the night. Next day we ascended by a sharp spur at the south-west corner to the summit.

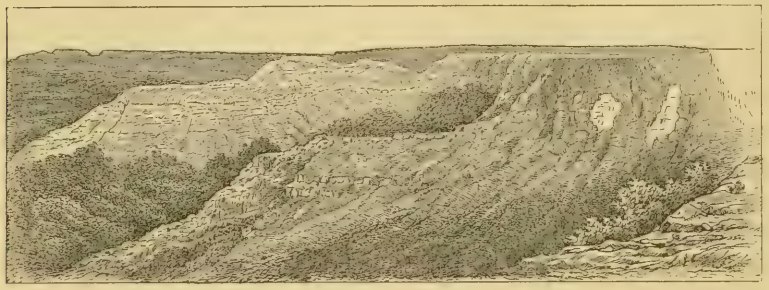
Parauaquára* is an extensive, isolated plateau of circumdenudation, and apparently forms a long, narrow, irregular strip, running east-west; at least so it appeared to me from the river. The summit is so densely covered with little trees that I could not traverse it, and I consequently have seen only the western and southern sides of the serra.

The following sketch, taken from a point a few miles west of the mountain, will show its topographical features as seen in elevation.

The following cut is from a sketch taken from the top of the serra looking off northward along the western side, showing the

* *Paruá*, parrot, and *quára*, hole.

level-topped summit, and the steep sides and spurs, along which run the edges of the horizontal strata like courses of masonry.



On the southern side of the serra, at the south-west corner, is an immense, concave, precipitous gulf like one-half of a volcanic crater, and on its sides a great thickness of rocks is exposed. The view on Plate VII. is from a sketch taken from the summit of the serra, just above the precipice, and looking westward across the gulf and the spur by which we ascended, out over the Amazonian valley. The sloping mass of Tauajurí is distinctly visible on the western horizon, while just to the south are the Monte-Alegre highlands between which and Parauaquára stretch immense plains, more or less completely covered with forest, with the exception of the campos near the Yauarí, which on the sketch look like a large lake. Far off to the north-ward these same wooded plains are continued to the long line of table-topped hills. They are rarely broken by a hill and there is but one little lake in sight. On the maps a large lake called Urubú-quára,* is represented lying between Tauajurí and Paráuaquará, but of this nothing is to be seen from the serra, the only lakes visible from this mountain or from Tauajurí being the little lagoon just spoken of, and which I have represented in my sketch, and the long, narrow, crescent-shaped lake lying between Monte-Alegre and Prámha.

The Amazonas bordered with forest, dotted here and there with islands, and enlivened by a white sail or a steamer, runs like a broad belt across the landscape, its reddish waters contrasting strongly with the green of the woodlands. We may trace it from the western horizon near Monte-Alegre, to far beyond Almeyrim. Parauaquára lies some ten miles, more or less, back from the river.

* *Urubú*, vulture, nd *kuára*, hole.

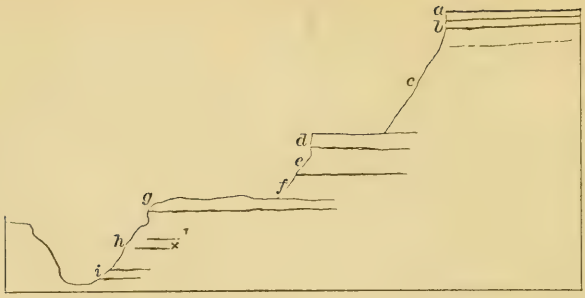
On the opposite side of the Amazonas, and to the south-west, immense alluvial plains with many large lakes stretch away to the dim, ill-defined horizon, but I could not make out the Xingú, which probably lies out of sight below the horizon.

The area of country one may survey from the top of Parauáquára is immense, and every topographical feature is seen as on a map. I could not but contrast the bird's-eye view from the serra, and the clear and comprehensive idea it gave me of this part of the Amazonian valley, with the meagre idea of the Amazonas one obtains by traveling by steam along the river, when all he sees is the broad turbid flood, bordered on each side by a strip of forest, with perhaps a few distant hills seen over the tree-tops; a few islands and a clear water horizon both in the east and west.

One traveling in this way sees actually nothing of the structural features of the valley, and he puts one in mind of an ant who makes an excursion up a Corinthian column following industriously along the bottom of a fluting.

The Amazonas has been "explored" quite sufficiently in this style, and the sooner travelers settle down to the conviction that the Amazonas, like the Mississippi or any other great river, is too big for one man to explore alone, even in a life-time, the better it will be for science. Mr. Chandless has set a good example to Amazonian travelers in his careful surveys of the Parú and of the Canumá, Abacaxí and Maué-Assú.

The following is a section made from the top of Parauáquára to its base. The exposures on the mountain side, are so poor and disconnected, and the sword-grass made the descent so painful that observations were made with difficulty, and I could not determine the thickness of the beds. The beds are given in the descending order.



a. The surface is covered with a few feet of a very fine, light brick-red earth consisting of a mixture of clay and very fine sand.

b. Red sandy clay packed full of nodules of iron-stone, which are elongate and stalactitic in form, and imbedded upright, so that the bed appears as if it were full of long, irregular roots. Thickness 8-10 feet.

c. Very heavy beds of Tauatínga clay of a grayish white color magnificently exposed in the cliffs on the south-eastern side of the serra, where they look white like chalk. These rocks are well bedded as seen in the sketch of the cliffs, but they are not laminated.

d. A thick bed of white clay, partly very pure Tauatínga, partly sand and often presenting a structure similar to that of a brick in which two kinds of clay have been imperfectly mixed together. The material of which this bed is composed bakes very hard in the sun, and, resisting denudation better than the overlying beds, it occasionally forms a projecting platform with bluff edges.

e. Soft, fine-grained sand-stone, white or cream-colored, and with a cement of clay.

f. Sandy clay, not laminated, variegated in color and irregularly solidified by iron oxide.

Leaving the serra and going eastward a short distance to a deep valley, the section appears to be continued as follows:

g. A heavy bed of a hard, fine and even-grained, white, argillaceous sandstone, beautifully variegated with bands and mottlings of delicate shades of red, purple, brown and yellow. This rock resembles very closely that of the little ridge just east of the igarapé of Ererê and may be of the same age; but, unfortunately, in the valley

of the Amazonas lithological characters are not much to be trusted in the identification of formations.

h. Series of beds not well exposed; at *x* are thin bands of coarse, red sandstone and iron-stone.

i. The lowest rocks seen were a thick bed of fine, very dark gray clay.

Not a single fossil was found in the Parauáquára beds, so that their geological age is undetermined. My own decided opinion that they are newer than the Cretaceous and probably of Tertiary must be taken for what it is worth, until the question is settled by palæontological evidence.

The following paper by Mr. Rathbun on the Brachiopoda of the Devonian of Ereré is the result of a long and careful study of the collections under my direction. At my request Mr. Rathbun took a suite of the fossils to Cambridge, Mass., and compared them with the collection in the Museum of Comparative Zoölogy. Prof. Agassiz received him with the greatest kindness, and gave him every facility for the examination of specimens. I have also to express my thanks to Mr. T. Cary, business manager of the Museum, and to my old friend Prof. O. H. St. John, for aid rendered to Mr. Rathbun.

Prof. Hall has since kindly examined the collection, and I am much indebted to him for allowing Mr. Rathbun to compare the Brazilian fossils with New York types in his collection. My thanks are also due to Mr. Whitfield for his courtesy in aiding in these comparisons.

I have published a very condensed sketch of the geology of the Ereré-Parauáquára district in the Transactions of the American Geographical Society, and the sketch-map at the head of this paper first appeared in that volume, but is now republished with several important changes.

XXIII. On the Devonian Brachiopoda of Erere', Province of Para', Brazil

BY RICHARD RATHBUN,
Of the Geological Laboratory, Cornell University.

[*Read before this Society January 2d*, 1874.]

Terebratula Derbyana, *Hartt*, sp. nov., Plate X, figs. 15, 17, 18, 19, 20, 21, 22, 24 and 25.

Test small, generally subovate in outline, but sometimes subangular posteriorly, lenticular, with nearly equally convex and somewhat flattened valves. Breadth usually about three-fourths, though sometimes nearly equal to, the length, and greatest at or anterior to the middle. Surface smooth.

Ventral valve depressed-convex, with the greatest convexity posterior to the middle. The beak appears to be more or less pointed, slightly extended beyond the dorsal valve and incurved, with quite a broad deltidium beneath; but the external moulds, owing to the friable character of the sandstone in which they were taken, are all more or less defective in the umbonal region. The posterior lateral margins, diverging from the beak at an angle a little greater or less than a right angle, and slightly rounded or nearly straight, extend forward nearly half the length of the valve, when they bend gradually to unite with the lateral margins, which, together with the front, form a single regular curve.

Dorsal valve generally slightly elongate, but sometimes nearly circular in outline, depressed-convex like the opposite valve, the convexity strongest posteriorly, the curve from the beak to the front being very gentle.

The surface of both valves is smooth, though sometimes it is traversed by several more or less prominent concentric lines of growth.

There is neither fold nor sinus, and altogether the test presents a very plain appearance.

Length, 10 m. m., breadth, 7.5 m. m., thickness, 3 m. m.

This species occurs quite abundantly in the Devonian sandstone of Ereré, associated with *Streptorhynchus Agassizii*, *Vitulina pustulosa*, etc. Many specimens of different ages are often found crowded together in a small space in the friable portions of the sandstone, and preserved in the form of external and internal moulds.

In the absence of the muscular markings and loop, it has been impossible to determine with accuracy whether this species is a true *Terebratula* or not, since, so far as external form is concerned, it might belong either to *Centronella* Billings, or to *Cryptonella* Hall. Until more perfect material shall have been collected, I have thought it best to refer the species provisionally to *Terebratula*, the most largely represented by species of the above genera. (Morgan Expeditions 1870 and '71.)

Named by Prof. Hartt in honor of his assistant, Mr. O. A. Derby, instructor in Geology and Palaeontology in Cornell University, and his companion on two expeditions to the Amazonas.

Spirifera Pedroana, *Hartt*, sp. nov., Plate VIII, figs. 1–9, 13, 14 and 16–20.

Test of moderate size, inequivalve, very transverse, thin. Breadth varying from twice, to three and a half times the length, being greatest along the hinge line. Outline sub-semi-elliptical or broadly sub-triangular, the lateral margins on each side forming a single, more or less strong, regular curve, though they are sometimes nearly straight. Cardinal extremities more or less produced and angular, varying from quite acute to nearly rectangular, often slightly rounded. Test plicate.

Ventral valve much more convex than the dorsal, sub pyramidal when young, more or less ventricose when old. Greatest elevation at or just in front of the beak, which is small, elevated, generally slightly incurved, but sometimes hardly produced beyond the hinge area. Hinge area moderately broad, triangular, nearly flat or slightly concave, perpendicular to antero-posterior diameter or slightly inclined forwards or backwards, in which last case it is generally slightly concave, the curvature varying somewhat but always more marked under the beak. Cardinal margins angular, nearly straight or curving very slightly inwards. Fissure triangular with the width at base about equal to the height. Mesial sinus of moderate depth and width, broader than deep and increasing gradually in size towards the front, where it is slightly produced beyond the margin of the valve. It is regularly rounded in the bottom, though sometimes slightly flattened towards the front; its surface is smooth and the margins are well defined. From the beak to the front, along the mesial line, the surface of the valve curves moderately and regularly, but never very strongly; sometimes it is nearly straight. The slope from the margins of the sinus to the cardinal extremities is very slightly convex but often nearly straight.

Dorsal valve moderately convex but sometimes much depressed, the elevation being greatest near the middle. Beak minute. Mesial fold prominent and abrupt, moderately wide, its breadth increasing regularly from the beak to the

front; sides very steeply inclined, top rounded and flattened, with usually a very shallow, longitudinal furrow, exceedingly narrow at the beak, but broadening and disappearing on approaching the front. The summit of the fold, from the beak to the front, describes a moderately strong curve, which tends to become more or less straight towards the front. The elevation of the fold in front is quite variable.

The test has, on each side of the fold and sinus, 10 to 16 simple, rounded, prominent plications, the reverse plications being of the same form but narrower. On the ventral valve, the plications bordering the sinus are sometimes slightly larger than the others, and are well defined up to the beak. Towards the sides they gradually decrease both in width and prominence, sometimes dying out entirely on the cardinal angles, which are thus frequently left smooth, as is also a narrow space extending just in front of the cardinal margins, to within a varying distance of the beak. At the sides of the fold in the dorsal valve, the plications arch rapidly from the beak, curving strongly to the front, but less and less so as the cardinal angles are approached, where the valve is more or less flattened, the plications diminishing in prominence towards the sides as in the ventral valve, but seldom leaving the cardinal angles smooth. Sometimes the valves are marked, usually towards the front, by one, two or three, seldom four, prominent lines of growth, and some impressions of the fold and sinus show indications of many fainter ones.

The dental plates of the ventral valve are thin, divergent, generally very short, though in the older specimens they sometimes extend forward nearly one-third the length of the valve, each including two or three plications between itself and the sinus.

The specimens vary much in dimensions, one large one measures, length, 15 m. m., breadth, 36 m. m., depth, 12 m. m.; another, 15, 45 and 12 m. m.

The test must have been a thin one, for the exterior markings are very plainly impressed upon the inner mould.

This species belongs to the group of *Spiriferae*, with broad hinge area and more or less extended sides, which is so common in the Devonian; but the collections at command for comparison have been so meagre that its relations to other species have been but imperfectly determined. It resembles closely *S. varicosa* of the Corniferous limestone, from which, however, it differs in the greater number of plications, which are not angular, and also in the narrower hinge area. Many of the smaller and more mucronate varieties approach *S. angusta* of the Hamilton group in shape, but in the latter species the plications are smaller and more numerous. From the European Devonian *S. sub-cuspidata*, Schnur, it differs, among other features, in the much narrower hinge area.

Prof. Hall, who examined a small number of specimens of this species of *Spirifera* after the above description was written, thinks that in its different varieties it is very closely related to several American Devonian *Spiriferae: S. varicosa*, Corniferous limestone; *S. medialis*, Hamilton group, which varies much in form; *S. angusta*, Hamilton group, perhaps only a variety or young form of *S. medialis*; and *S. macra* of the Corn. l. s., which last species, however, has generally a narrower and more curved hinge area. *S. Pedroana* therefore appears almost like a connecting link, uniting the above named species in a single series.

This *Spirifera* is one of the most common and beautiful fossils in the Devonian sandstones at Ereré, probably coming next to *Streptorhynchus Agassizii* in abundance. So far as is at present known, it is almost entirely, if not quite confined to the sandstone. But a single very small ventral valve of a *Spirifera* has been found in the underlying shale, which agrees with the species just described in general outline; it is, however, a little narrower, and appears to have a small median septum which would ally it with *Spiriferina*; but this last character is obscure in the specimen, and cannot be relied on. (Morgan Expeditions 1870 and '71.)

[I have taken the liberty to dedicate this beautiful and interesting species to His Majesty, the Emperor of Brazil, an accomplished geological observer, and one whose distinguished patronage and sympathy many a scientific traveler in Brazil will remember with the deepest gratitude.—C. F. H.]

Spirifera Elizae, *Hartt*, sp. nov., Plate VIII, figs. 15 and 21; and Plate IX, fig. 22.

Of this species only the ventral valve is known. This is of medium size, transverse, the breadth being about twice the length; nearly semicircular in outline, the sides and front forming a very regular curve, indented only slightly in front by the depression of the sinus; depressed sub-pyramidal in form, most elevated in the umbonal region. Beak obtusely angular, elevated, not produced beyond the hinge area in the internal moulds. Hinge area triangular, slightly concave and inclining a little backwards; cardinal margins angular; fissure triangular. From the margins of the sinus the valve slopes on each side with scarcely any curvature to the cardinal extremities, but from the beak to the front it curves slightly, the sides of the valve presenting there

fore a flattened appearance. Mesial sinus extending to the beak, moderately deep and wide, regularly rounded in the bottom, and, at the front, less than one-fourth as deep as wide.

Surface of test with twelve or more low, very indistinct, rounded, radiating plications on each side. These are rather more pronounced near the sinus, but gradually disappear towards the sides.

The impressions of the dental plates, in the interior mould, start quite near together at the beak, and extend, parallel with and exterior to, the diverging margins of the sinus, nearly or quite to the front of the valve, the space between the dental plates and the margins of the sinus including one or two plications. In one specimen, Plate VIII, fig. 21, one plication is included in this way on one side, and two on the other.

The type specimen, a ventral valve, is 17 m. m. long, 34 m. m. broad and about 5 m. m. high.

This species is based on more or less perfect specimens of four ventral valves, of which three are internal moulds, and the fourth an impression of the exterior surface. Though these agree sufficiently well together to warrant the conclusion that they belong to the same species, there are, however, some points of difference between them.

The surface in all the above specimens is nearly smooth, and the dental plates are always long, reaching almost to the anterior margin of the valve. The specimen taken as the type is very regular, the margins of the sinus and the bases of the dental plates are straight; but in some of the other specimens the margins of the sinus are irregular, curving more or less, and the sinus is narrower, with the dental plates removed farther from its margins. These variations do not seem to be produced by distortion, but they might be due to irregular internal thickening. This question, together with that of the thickness of the test, cannot be determined from the present condition of the casts.

In shape this species somewhat resembles *S. Pedroana*, with which it is associated at Ereré; but it is easily distinguished from that species by the very long dental plates and the nearly smooth surface. On comparing it with those varieties of *S. disjuncta*, Sow., which have long dental plates, as represented by Prof. Hall: Pal. N. Y., Vol. IV, Pl. 42, Fig. 17, and Pl. 63, Fig. 14, there is seen to be a great resemblance, but all the specimens of *S. Elizae*, which show plications on the sides have a perfectly smooth sinus, and this is the case in the external as well as in the internal moulds.

Associated with *Sp. Pedroana*, in the Devonian sandstones of Ereré. (Morgan Expedition 1871.)

[Dedicated respectfully to Madame Elizabeth C. Agassiz.—C. F. H.]

Spirifera Valenteana, *Hartt*, sp. nov., Plate VIII, fig. 11.

Test above medium size, ventricose, thick, trilobed in outline and slightly transverse, with the greatest width along the hinge line.

Ventral valve very convex, most elevated between the beak and the middle. Cardinal angles depressed, with the cardinal margins concave. Beak probably large and curving over a rather constricted area. The margin of the valve is distinctly trilobed, caused by the extension forward of the broad mesial sinus beyond the general margin of the valve; leaving the cardinal extremity on one side at nearly a right angle, it curves regularly inward for more than one-half the whole length of the valve and one-fifth the width, when it gradually bends outward, forming a shallow reëntrant curve before reaching the forward projection of the sinus, around which it extends in an elliptical curve. The distance across, from the center of one reëntrant curve to the other, is about twice the length of the prolongation of the sinus beyond the general margin of the valve. Mesial sinus very broad and shallow, regularly rounded in the bottom, and with its margins undefined; width of sinus nearly one-half the width of the valve, the whole anterior lobe of the valve being occupied by it; in the cast it is nearly as broad near the beak as at the front. The surface of the valve curves regularly and quite strongly from the beak to the front margin; from each side it curves rapidly upward for about one-fourth the width, and then descends gradually to form the sinus, which is very slightly and regularly concave.

The dental plates, as indicated by the moulds, were very high and thick behind, thinning out gradually as they advance. They are widely separated, the distance between them being nearly one-third the width of the valve, and they extend forward, parallel with each other, for two-thirds the length of the valve.

Between the dental plates in the mould are indistinct impressions of muscular markings, consisting of an ovate, slightly depressed space, rounded behind, where it is immediately enclosed by the dental plates, and gradually narrowing to a point anteriorly, not extending as far forward as the dental plates. This impression seems, however, too limited to include all the muscular markings of the ventral valve.

But one specimen of this singular species, a cast of the interior of the ventral valve, has been found, and though peculiar in shape, it appears to belong to the genus *Spirifera*. The test was very heavy, and, including the dental plates, was much thickened by

internal growth, while the whole interior of the beak was filled up. The surface of the mould is smooth, and does not enable us to decide whether the test was ornamented or plain.

The single specimen measures as follows: length about 25 m. m., breadth about 34 m. m., height about 7 m. m.

From the Devonian sandstone of Ereré, found with *S. Pedroana* and *S. Elizae*. (Morgan Expedition 1871.)

[I have named this species in honor of Capitão Valente, of Monte-Alegre, a gentleman to whom I am under the deepest obligations for hospitality, and for most important aid rendered me in my explorations of the Ereré-Monte-Alegre district.—C. F. H.]

Cyrtina? Curupira, *Rathbun*, sp. nov., Plate X, figs. 1 and 6.

Ventral valve unknown. Dorsal valve small, moderately or very convex, and most elevated just behind the middle, transverse, sub-semicircular in outline, with the breadth nearly or quite twice the length, and apparently greatest along the straight hinge line; but the cardinal extremities in all the specimens are defective, making it impossible to determine whether they are angular or slightly rounded. The sides curve moderately, and the anterior margin is nearly straight in front of the fold. From the front, along the median line, the valve rises more or less rapidly, with quite a strong curvature, for two-thirds or three-fourths its length, and then descends in an abrupt curve to the hinge line, there being no apparent beak. Median fold moderately elevated above the surface of the valve, broad, and composed of three plications, of which the two outer ones are very prominent and regularly rounded, the median one being broader but not so high, and slightly flattened along the top. The fold commences near the hinge line, where it is moderately broad, increasing gradually in width towards the front, but seldom gaining much in height. The sides of the valve slope off more or less abruptly towards the cardinal angles, which are broadly flattened. On each side there are generally three rounded plications, not so large as those on the fold, and sometimes much depressed; they are usually narrower than the reverse plications, and increase gradually in width towards the margins, diminishing, however, in size towards the cardinal angles, which last are smooth.

At first sight, the specimens on which the above species is founded, might be taken for dorsal valves of *Vitulina pustulosa*, with which species it is associated in the Devonian sandstone at Ereré; but, as the above description shows, it is very different. Without the ventral

valve it is impossible to determine the genus accurately; but the specimens resemble closely the dorsal valves of a *Cyrtina*, though the fold is different from that of any described species. In this latter feature the species resembles *Cyrtina? amblygona*, Phil. Subcarb. Eng. (Davidson, Pal. Soc.), and I have therefore referred it provisionally to the same genus. It seems very strange that while dorsal valves of *C.? Curupira* have been found, not a single ventral valve has yet been detected.

Prof. Hall, who examined the specimens, thought that they might prove to be something besides *Cyrtina*, but was in doubt as to their generic affinities. They have much the appearance of a *Spirifera*, but one specimen seems to be marked, though very indistinctly, with fine, radiating, raised lines, a character which is unknown in any *Spirifera*, plicated as this one is. (Morgan Expeditions 1870 and '71.)

It receives its name from Kurupíra, Lingoa Geral, a forest spirit of Tupi mythology.

Retzia* Jamesiana, *Hartt*, sp. nov., Plate X, figs. 23 and 27–38.

Test small, longitudinally suboval in outline, more or less angular posteriorly, with the greatest width near the middle. Proportions of length to breadth variable; breadth usually nearly equal to, sometimes three-fourths the length. Ventricose, occasionally flattened and lenticular; ventral valve more convex than the dorsal. Beak of ventral valve extended beyond the dorsal valve. Valves plicated.

Ventral valve quite regularly convex, the greatest elevation being at or just behind the middle. The curvature from the front along the median line is usually very regular and moderately strong up to the beak, along which it is slightly more abrupt. From side to side the valve is very strongly convex, and, rising rapidly from the lateral margins, generally with slight curvature, it is regularly and well rounded on the median line. Beak projecting considerably beyond the dorsal valve, and rather strongly arcuate. The posterior lateral margins of valve diverge at an angle, varying from a little more to a little less than a right angle; they may be slightly convex or nearly straight, but are generally somewhat concave for a short distance, when they bend round and join the lateral margins, which, together with the front, form a regular curve equal to a little more than a semicircle. Surface marked by 14–20 low, rounded,

* Mr. R. P. Whitfield writes me that "the genus *Rhynchospira* will have to be dropped entirely, as *Retzia Adrieni*, Vern., appears to be generically the same as *R formosa*, Hall's type of *Rhynchospira*."

simple, radiating plications, separated by slightly narrower, rounded depressions. The plications, which are very distinct at the front, extend backwards from one to two-thirds the length of the valve, when they disappear, leaving the entire unbonal region smooth. The depression, occupying the median line, is about twice as wide as the others, but only slightly deeper, and extends nearer to the beak. It is flattened along the bottom, and very rarely includes a slight fold in the middle. The plications on the sides of the valve do not vary much in size, those bordering the central depression being only slightly larger than the others. Thin dental plates, starting on each side of the beak, and diverging but slightly, extend forward along the valve for about one-fifth its length.

Dorsal valve sub-circular in outline, sometimes a little angular behind, more or less depressed-convex, sometimes very much depressed, with the greatest elevation behind the middle. Beak sharp, its margins forming nearly a right angle, depressed, and appearing not to project beyond the hinge line. The plications of this valve correspond in number and character to those of the opposite valve, being distinct on the front, while the posterior part of the valve is smooth. The plication occupying the median line is slightly enlarged, corresponding to the median depression in the ventral valve. It is flattened on the top, scarcely more prominent than other plications, but extending nearer to the beak.

The largest specimen obtained, a ventral valve, measures, length 11 m. m., breadth 10 m. m., height 3 m. m.

This species occurs very abundantly in the Devonian sandstone at Ereré, associated with *Streptorhynchus Agassizii*, etc. The area, deltidium and loop, are not preserved, but from external features it appears to approach more nearly to *Retzia* (*Rhynchospira*) *lepida*, Hall, Hamilton group, than any other species; but I have no specimens for comparison. In ornamentation it resembles *Retzia radialis*, Phil., Carb., Eng. The plications in *R. Jamesiana*, however, are smaller, but the median plication on the dorsal valve, and the corresponding sinus on the ventral valve, are enlarged as in *R. radialis*.

The extension of the dental plates to the bottom of the ventral valve in the new species, is very distinctly shown in some of the interior moulds, a character which, hitherto, has seldom been found in any species of *Retzia;* but it is not safe to decide on its value until the interior of *Retzia* is better known. (Morgan Expeditions 1870 and '71.)

[In dedicating this species to my old friend, Maj. O. C. James, of Rio de Janeiro, I desire to express my deep feeling of gratitude, for

his generous aid towards fitting out three different expeditions to Brazil, and for his constant, warm sympathy with my scientific pursuits.—C. F. H.]

Retzia Wardiana, *Hartt*, sp. nov., Plate X, figs. 2–5, 8, 9, 11, 12, 14 and 16.

Test small, double convex, more or less ventricose, the ventral valve being usually the more convex; longitudinally suboval, slightly angular behind; usually a little longer than wide, though the width sometimes equals the length, greatest width near the middle; whole surface finely plicated.

Ventral valve most convex near the center, curving regularly and moderately, sometimes quite strongly, from beak to front, and very strongly from side to side. Beak more or less pointed and slightly incurved. Posterior lateral margins of valve straight, slightly convex or concave, including an angle equal to, or a little more than, 90 degrees. The front and lateral margins together form a little more than a semicircle. The bases of the dental plates are parallel and extend very slightly forward, the distance between them being nearly one-fourth the width of the valve.

Dorsal valve nearly circular in outline, sometimes a little elongate, generally slightly and regularly convex, the beak being much depressed.

Each valve is ornamented by from 14-20 (in one case 22,) simple, narrow, rounded, or subangular, very prominent, radiating plications which extend over the whole surface, being traceable from the beak, where they are very narrow, to the front, towards which they gradually increase in width and prominence. These plications do not differ much in size, being only a little smaller towards the lateral margins than in the middle. The depressions separating the plications are narrower than they, and rounded or angular.

A medium sized ventral valve measures, length 10 m. m., breadth 8 m. m., thickness about 3 m. m.

This species occurs quite abundantly in the Devonian sandstones of Ereré, associated with *R. Jamesiana*, which last is, however, much more common. The two species resemble one another closely in size and general form, but they differ totally in ornamentation, the difference being so marked that the species are readily distinguished, even by fragments of valves; moreover, no intermediate forms have been observed. *R. Jamesiana* always has low, indistinct plications not extending to the beak, while those of the species just described are always very prominent, extending from the beak to the front. The enlarged median plication and depression are also a constant character of *R. Jamesiana*. (Morgan Expeditions 1870 and '71.)

[I have attached to this pretty species the name of my old friend, Mr. Thos. Ward, the explorer, of the Tocantins on the Thayer expedition, and one to whom I am under a deep debt of gratitude for aid in my first journey to the Amazonas in 1870.—C. F. H.]

Rhynchonella (Stenocisma) dotis, *Hall*, (Palaeontology of New York, Vol. IV, p. 344,) Plate VIII, figs. 10 and 12.

Of the Ereré form the ventral valve is unknown.

Dorsal valve rather below the medium size, of moderate convexity, which is stronger towards the front, quite flattened near the middle; slightly transverse with the greatest width midway between the beak and the front; very short-ovate in outline, slightly truncate in front, and angular behind. The nearly straight posterior lateral margins diverge at an angle of about 110 degrees, and extend less than one-third the length of the valve, the lateral margins rounding quite strongly and regularly to the edge of the fold, in front of which the margin is nearly straight. From the depressed beak the valve rises quite abruptly for a short distance along the median line, and then continues with a very gentle curve, or nearly straight, to the front. On each side, it rounds up strongly for one-fourth the width or more, and is nearly flat in the middle. The mesial fold commences just anterior to the middle, and increases very gradually in width, being but slightly prominent at the front. The valve has about 16 plications, of which four occupy the fold. The plications are prominent, varying in width, being usually rounded near the middle of the valve, but becoming angular towards the sides, with the reverse plications generally narrower. The first one or two on each side next the fold extend nearly directly from the beak to the margin, the others, in succession, curving more and more strongly outward toward the lateral margins, and decreasing in size, those on the extreme sides being very small and angular. A narrow septum extends forward from the beak, for about one-third the length of the valve.

The most perfect specimen measures, length 11 m. m., breadth 13 m. m., height about 3.5 m. m., width of fold in front about 5 m. m.

This small species of *Rhynchonella* is probably identical with *R. dotis*, Hall, Hamilton group, N. Y. The specimens from New York vary much in the character of the plications, which are sometimes very angular, and at others well rounded. In the Brazilian specimens, so far obtained, the plications are of an intermediate character.

From the Devonian sandstone of Ereré, Prov. do Pará, Brazil, obtained with *Streptorhynchus Agassizii*, *Retzia Jamesiana*, etc. (Morgan Expeditions 1870 and '71.)

Orthis Nettoana, *Rathbun,* sp. nov., Plate X, figs. 7, 10 and 13.

Test very small, with the valves unequally convex. Ventral valve sub-circular in outline and longer than the dorsal, owing to the greater extension of the beak. Dorsal valve broadly sub-elliptical in outline, slightly straightened posteriorly, with the breadth greatest across the middle, and about one and one-fourth the length. Breadth at hinge line apparently about two-thirds the greatest width of the test; cardinal extremities rounded; both valves marked with very fine radiating raised lines.

Ventral valve very convex, and most prominent just behind the middle. From the beak, which is elevated and acute, the surface of the valve curves slightly upwards, and then slopes to the front with a regular and gentle curve. Towards the sides the slope is more abrupt and slightly convex. Hinge area rather high, triangular, with a large fissure.

Dorsal valve slightly convex, broadly flattened in the middle, and often more or less depressed along the median line, in a wide, undefined sinus, extending two-thirds the length of the valve or more from the front, with its width in front one-third to one-half the greatest width of the valve. Beak depressed.

The impressions of the dental lamellae in the ventral valve diverge slightly in extending forward, the distance between them being about one-fifth to one-fourth the width of the valve, and their length, about one-fourth that of the valve. The socket plates in the dorsal valve left similar impressions.

The raised lines, ornamenting the valves, are exceedingly fine, rounded and thread-like, closely arranged together, and seem to increase both by intercalation and bifurcation.

The largest ventral valve measures, length and breadth, each about 6 m. m., height nearly 2 m. m. The largest dorsal valve has a breadth of 7.5 m. m., a length of about 5 m. m., and a height of nearly 1 m. m.

This is a very small species of *Orthis*, being of about the same size as *Orthis lepidus* of the Hamilton group, but differing totally from it in shape. It can be easily distinguished from the young of *Streptorhynchus Agassizii*, with which it is associated, by the much finer radiating, raised lines, and by the extension forward of the dental plates in the ventral valve, and the socket plates in the dorsal valve.

From the Devonian sandstone of Ereré, where it is moderately abundant. (Morgan Expeditions 1870 and '71.)

Dedicated to Dr. Ladisláu Netto, the distinguished director of the Muzeu Nacional at Rio de Janeiro.

Streptorhynchus Agassizii, *Hartt*, sp. nov., Plate IX, figs. 3, 4, 10, 16, 17, 23, 25, 26 and 28-30.

Test small or of moderate size, never very large, transverse, double convex, or with the ventral valve sometimes slightly and irregularly flattened, or even concave towards the front. Valves subequally convex, varying much in outline; sometimes unsymmetrical; often circular, with the sides and front forming a segment of a more or less perfect circle, embracing two-thirds to three-fourths the diameter; in some cases sub-elliptical; seldom transversely oblong. Greatest width at or a little behind the middle. Cardinal extremities rounded or obtusely angular, but in a single known instance slightly extended into mucronate points. Proportions of length to width about as 2 to 3, 3 to 4, or 3 to 5. Hinge line straight, beak of ventral valve elevated and pointed, that of dorsal valve being depressed and broadened. In size, the test varies from very young and small to 21 m. m. long, by 32 m. m. broad, and one unusual specimen measures 29 m. m. long by 40 m. m. broad. Surface ornamented with very fine raised lines.

Ventral valve most prominent at, and in the neighborhood of the beak. Extremity of beak generally elevated above the rest of the valve, with the surface of the valve sloping more or less irregularly towards the sides and front, and either straight, slightly concave or somewhat convex; or the beak may be a little depressed, the surface rising from it for a short distance, and then continuing to the front and sides as in the former case. In a few exceptional instances, the valve is regularly and strongly convex, from the beak nearly to the front; but the general tendency in all specimens is, for the surface to flatten out toward the front and sides. Beak acute, seldom perfectly symmetrical, generally bent a little to one side or the other, or slightly twisted; never extending much beyond the hinge area, and incurving but little. Hinge area nearly or quite as long as the hinge line, of moderate width, trianangular, inclined backward, and with the cardinal margins acutely angular. The area is never symmetrical in outline, and its form varies as the beak is bent or twisted. The cardinal margins are generally concave, though they vary in degree of curvature in the same specimen, and may be slightly convex on one side of the beak, and concave on the other. In extending towards the cardinal extremities, they generally bend more or less abruptly towards the hinge line, sometimes approaching quite near to it at some distance from the extremities, so that the hinge area may be very narrow at the sides, and appear as if quite short. The surface of the valve sometimes arches up quite rapidly on the sides, from the cardinal margins, for a short distance. Fissure of moderate size, triangular, the width at base equal to or slightly exceeding the height, covered by a very convex deltidium. The impressions of the dental plates in the internal moulds are visible only on the hinge area, at the sides of the fissure, appearing as shallow depressions not extending forward into the valve.

Dorsal valve more symmetrical than the ventral, the convexity being either moderate, or strong and regular, though sometimes the valve is more or less depressed-convex, or flattened in the middle, often with a tendency to form a shallow, undefined depression or sinus, commencing a short distance in front of the beak, and extending towards the front margin, broadening gradually at the same time. This sinus is found only in the more depressed specimens, and, when deepest, it forms only a slight undulation of the surface. The valve is most prominent at or posterior to the middle; in the former case, the curve from the depressed beak to the front is very regular, but in the latter case, it arches up somewhat rapidly from the beak, and then slopes off more gradually towards the anterior margin. Across the middle of the valve, from side to side, the curve is seldom regular, the surface generally rises with but little curvature for a varying distance from the margin, and then extends straight across the center, or, if the specimen have a sinus, it is there slightly depressed. The cardinal extremities are more or less flattened, and this flattened area sometimes extends along the cardinal margins, narrowing to a point near the beak. A line from the cardinal extremities to the middle of the valve, forms a slight sigmoid curve. Beak depressed and not extending behind the hinge line, which is straight, and, in a single instance, slightly extended beyond the sides of the valve. Cardinal process small, thin, bifid above, with the two small processes on each side projecting backwards. A small projection in the center below, extends a little forward and towards the ventral valve. Socket plates short, thin, very divergent, forming an angle of about 135 degrees.

The surface of both valves is marked by very fine, rounded, thread-like or sharp, raised lines, increasing in number by intercalation, and probably in some cases by bifurcation also. The interspaces are slightly flattened and broader than the lines. One set of raised lines commences at the beak and extends to the margin, each line being exceedingly minute at the beak, but increasing very gradually in size. The intercalating lines generally begin to come in posterior to the middle, and thence, to the front and sides, new ones are continually being added, until the number at the margin is about double that near the beak, there being generally but one intercalating line for every interspace commencing at the beak. In some specimens concentric lines of growth are faintly preserved.

There seems to be no limit to the degree of variation which a species of *Streptorhynchus* may assume. It may be symmetrical in some specimens and unsymmetrical in others. The margins may differ much in outline, and the hinge area vary in width from a few lines to several inches. The beak may or may not be extended, and turned and twisted to an enormous extent, and the surface markings may be fine or coarse. Thus we have no limited and

definite characters, on which to form species, and it is only by comparing together very large collections of specimens, that we are enabled to determine specific relations.

Davidson is inclined to acknowledge but one species of *Streptorhynchus* from the Devonian and Carboniferous of Europe, and Prof. Hall has also united the numerous Devonian forms of America under one specific name. But from the descriptions given by these two noted Palaeontologists, and from the specimens at command for comparison, there seems to be as much difference between the Ereré forms, and *S. crenistria* or *Chemungensis*, as exists between the latter two species themselves.

In *S. Agassizii* the raised lines are always very fine, regular, and, almost without exception, arranged closely together. The beak is never much extended, twisted or turned to the side, and the hinge area retains about the same width in all the specimens, never being wide, while altogether the test is never very unsymmetrical.

It is true that these characters may seem to be varietal, but they obtain through all the specimens collected at Ereré, which amount to over 500 in number, more or less perfectly preserved, all of which have been carefully compared with one another.

Devonian sandstone of Ereré. (Morgan Expeditions 1870 and '71.)

[This species, the most common of the Ereré fossils, I have dedicated to my honored teacher, Prof. Agassiz.—C. F. H.]

Chonetes Comstockii, *Hartt*, sp. nov., Plate IX, figs. 5, 14, 18, 19 and 31.

Test rather above the medium size, depressed-concavo-convex, transverse, with the breadth one and one-half to one and three-fourths the length, and greatest along the hinge which is straight. The cardinal extremities are acutely angular, and, though always defective, are sometimes probably slightly produced, as is shown by the lines of growth on one or two specimens. The outline is somewhat sub-quadrate; the lateral margins, slightly rounded, extend forward, nearly parallel with one another, for about one-half the length of valve, when they bend rapidly round to unite with the anterior margin, the outline of which is more or less gently convex.

Ventral valve very slightly convex, generally most prominent just posterior to the center, whence it slopes with slight curvature to the front, the curve from the same point to the beak being more rapid. Across the valve, from side to side, the curvature is gentle and more or less regular, the sides towards the cardinal angles being usually more or less, sometimes very much, flattened.

Beak very small, depressed to and hardly projecting beyond the hinge area, which is narrow, linear, and apparently as long as the hinge line. Median septum in the interior very small and short, about one-fourth the length of the valve. Associated with one of the interior moulds, is the impression of a single spine, which is nearly two-thirds as long as the valve, very slender, and about the same size throughout the part preserved.

Dorsal valve imperfectly known. In the collection from Ereré is a single interior mould of the dorsal valve of a *Chonetes*, that appears to belong to this species. It is slightly concave, but the margins are broken away. The cardinal process is only sufficiently preserved to show that it is divided through the middle, and extends inwards and slightly backwards. The median septum is faintly indicated, as are also the backward extensions of the vascular impressions near to it on each side. The muscular impressions are not preserved.

There is the exterior mould of the dorsal valve of another and a much larger specimen, which probably also belongs to this same species. It measures 38 m. m. in breadth by about 21 m. m. in length, and is proportionately more convex than the other specimens, but the outline appears to be the same. The surface markings are not preserved. The impression of the hinge area of the ventral valve lies behind it, showing, that, when the specimen was imbedded, the two valves were joined together. At the fissure, which is small and triangular, the area is 2 m. m. broad, but it narrows gradually towards the cardinal angles. It lies nearly in the same plane as the margins of the dorsal valve.

The test is marked with very fine raised lines, which are low and rounded, but, from their imperfect preservation, the manner in which they increase in number can not be determined. There are about fifteen of the lines within a space of 5 m. m. near the front.

Two ventral valves measure as follows: length 17 m. m., breadth 26 m. m., depth nearly 3 m. m.; and 12 m. m , 21 m. m. and about 2 m. m.

This is a pretty species, resembling much *Chonetes coronata*, Con. Hamilton group, New York and Western States; but it differs from that species in having longer spines, not extending so obliquely backward.

Moderately abundant in the Devonian sandstone of Ereré, associated with *Streptorhynchus Agassizii*, *Vitulina pustulosa*, etc.

[Named in honor of Prof. T. B. Comstock, photographer to the Morgan Expedition in 1870.—C. F. H.]

Chonetes Herbert-Smithii, *Hartt*, sp. nov., Plate X, figs. 39–42 and 44–47.

Test small, concavo-convex, transverse, semi-oval or broadly semi-elliptical in outline. Width greatest at the hinge line, and equal to about one and one-third the length. Cardinal extremities forming nearly right angles; the

lateral margins, nearly straight, or gently convex, extending forward one-half the length of the valve or more, and then forming, with the anterior margin, a very regular curve around the front.

Ventral valve moderately convex, usually with the greatest elevation just behind the middle, whence, with a regular curve, it slopes more or less rapidly to the front. Towards the beak it curves quite abruptly, while across the middle the curvature is moderately strong and regular. In a few instances, however, the valve is most prominent in the middle. The sides curve slightly inwards towards the cardinal angles, which are flattened or slightly reflected, making the curve thence to the center of the valve slightly sigmoidal. Beak much depressed, with the small, acute apex scarcely projecting beyond the hinge area. Septum small and about one-fourth as long as the valve. The number and length of the spines is unknown. The impressions of a portion of two of them are preserved, with the exterior mould of one specimen; these are slender, and diverge obliquely outwards from the cardinal margin, their length being about one-fourth that of the valve.

Dorsal valve varying from moderately to very slightly concave, most depressed towards the front, and rising gradually towards the hinge line, along which, and at the cardinal angles, the valve is often flattened.

The raised lines, with which the valve is ornamented, are small and rounded, and increase very slightly in size towards the front, where they number from 15 to 23 or more. But from the imperfect preservation of the moulds in the sandstone, the lines are always obliterated on the sides and the posterior part of the test, while, in many cases, the whole test is thus rendered smooth.

One specimen of ordinary average size measures 7 m. m. in length, 9.5 m. m. in breadth, and 2 m. m. in height.

This species, in its typical forms, seems to be related to *Ch. armata*, Bouch., Dev. Inf., Boulonnais, France, with specimens of which I have very carefully compared it. The Brazilian species is, however, a variable one, and the radiating lines are always coarser, and, when well preserved, are more prominent than in *C. armata*. The ventral valve of *C. armata* is also generally more elevated.

The specimens of *C. Herbert-Smithii*, on which the ornamentation is well preserved, resemble somewhat in general appearance both *C. deflecta*, Hall, and *C. laticosta*, Hall, of the Corniferous and Hamilton groups; but a close examination shows that, in shape, the Ererê species differs entirely from those of New York. The beak of the former species is always much depressed, while in the latter it is prominent, the whole umbonal region of the test being much elevated.

Obtained from the Devonian sandstone of Ereré, where it is very abundant, occurring with *Vitulina pustulosa*, *Spirifera Pedroana*, *Retzia*, etc. (Morgan Expeditions 1870 and '71.)

Named in honor of Mr. Herbert H. Smith, one of the assistants on the Morgan Expedition of 1870.

Chonetes Onettiana, *Rathbun*, sp. nov., Plate X, figs. 43 and 48.

Test below medium size, gibbous, transverse, semi-elliptical in outline, with the width probably greatest along the hinge line, and equal to about one and one-third or one and one-fourth the length; anterior margin not very strongly rounded.

The ventral valve is very convex, being well rounded from the beak to the front; most prominent at or just in front of the middle, where it is very slightly flattened. The valve rises more or less rapidly from the sides, in a curve which becomes a little straightened across the middle. The sides are somewhat flattened towards the cardinal angles, which last are slightly reflected. Beak small, depressed, with the minute apex projecting but slightly beyond the hinge line. Median septum small and well defined, about one-fourth as long as the valve.

Dorsal valve unknown.

The interior moulds are ornamented with fine, radiating, raised lines, but very indistinctly preserved on the specimens obtained. Length 11 m. m., breadth about 15 m. m.

From *C. Herbert-Smithii* this species is easily distinguished, by its larger size and the finer radiating lines. It may prove to be a variety of *C. scitula*, Hall, Hamilton group, New York, but the specimens of *C. Onettiana* are larger than those of *C. scitula*, and differ from them in many details.

Associated with *Spirifera Pedroana*, etc., in the Devonian sandstone of Ereré. (Morgan Expedition of 1871.)

Dedicated, at Prof. Hartt's suggestion, to Senhor Onetti of Monte-Alegre, to whom he is much indebted for aid rendered in his Expeditions of 1870 and 1871.

Chonetes ....., Plate IX, fig. 24.

There was obtained from Ereré, a single specimen of a ventral valve of *Chonetes*, of about the same size as the last species described, which differs from it, however, both in shape and in ornamentation.

Ventral valve below medium size, moderately convex, transverse, with the proportions of length to breadth about as 3 to 4; hinge line equal to the greatest width of test; cardinal extremities apparently acute-angular. The valve is most elevated just posterior to the middle, whence to the front the surface extends in a moderate slope, and is slightly curved, but towards the beak it is more strongly curved. The valve curves regularly and moderately strongly across the middle, becoming very slightly flattened towards the sides. The cardinal angles are also somewhat flattened. The inner mould of the valve is marked by small, subangular, radiating, raised lines, which, on the single specimen obtained, are only preserved towards the margins. The lines are separated by rounded depressions of equal or slightly greater width. Length of specimen 9 m. m., width on the hinge line 13 m. m.

This specimen of *Chonetes* is undoubtedly different from any of the three species of *Chonetes*, described in the preceding pages; but since only a single specimen has been found, and that is not a very perfect one, I have thought it best not to give it a name until better material has been obtained for illustrating the species.

Tropidoleptus carinatus, *Con.* (*Sp.*) Plate IX, figs. 1 and 9, and Plate X, fig. 26.

Strophomena carinata, Con. Ann. G. R. of N. Y., 1839, p. 64.
Leptaena laticosta, Hall, 1843.
Leptaena laticosta, of Owen and others.
Tropidoleptus carinatus, Hall, 10th Rep. St. Cab. N. Y., 1857, p. 151.
Genus *Tropidoleptus,* Hall, 12th Rep. St. Cab. N. Y., 1859, p. 31.
Leptaena laticosta, of several European geologists.

Description of Ereré forms:

Test of medium size, plano-convex, transverse, semi-elliptical in outline, sometimes slightly straightened in front, with the breadth about one and a third to one and a half times the length, and greatest along the hinge line which is straight. Cardinal angles slightly acute. Surface plicate.

Ventral valve moderately convex, most elevated midway between the beak and the center, whence it curves rapidly backwards, sloping to the anterior margin along the middle with a very gentle curvature. From the flattened cardinal angles, the surface rises gradually on each side, being slightly concave for a varying distance (one-half the width of the side or less), when it curves regularly across the median line, very strongly on the posterior half, but less and less so anteriorly. There is thus formed behind the center a sort of undefined prominence, that broadens rapidly towards the front, gradually flattening out and blending with the general curvature of the valve. Beak small, quite strongly arcuate, and slightly extended beyond the hinge line in the interior

moulds. Hinge area very narrow, with the cardinal margins concave. Dental lamellae prominent, placed at right angles to one another.

Dorsal valve flat or very slightly concave, represented by only a single fragmentary specimen, preserving the interior processes in too imperfect a condition for description.

On each valve there are about 14 to 16 low, rounded, often obscure, radiating plications, of medium size, generally broader than the reverse plications, though frequently equaling them in width. They are smaller, and sometimes more distinct near the beak than at the front, the cardinal angles and the sides being always smooth for a greater or less width, while the front is frequently nearly smooth.

One ventral valve measures as follows: Length, 14 m. m., breadth, 21 m. m., height, about 3 m. m.; another, 14 m. m., 18 m. m., and about 3 m. m.

It is impossible to separate the specimens of *Tropidoleptus* of Ereré, from those forms of *Tropidoleptus carinatus* of New York, which are not carinate along the median line.

Obtained with *S. Pedroana*, etc., from the Devonian sandstone of Ereré, where it is moderately abundant. (Morgan Expedition 1871.)

Vitulina pustulosa, *Hall,* Plate IX, figs. 2, 6–8, 11–13, 15, 20, 21, 27 and 32.

Vitulina pustulosa, Hall, 13th Rep. St. Cab. N. Y., 1860, p. 82.
Vitulina pustulosa, Hall, Pal. N. Y., Vol. IV, p. 410.

The test of the Ereré forms is of moderate size, with the ventral valve very convex, and the dorsal valve flat or very slightly convex; transverse, the breadth varying from one and one-fourth to one and one-half times the length, and greatest at or just anterior to the hinge line, which last is straight. Cardinal extremities usually subangular in young specimens, but becoming rounded in the larger and full grown ones. Lateral and anterior margins forming together a very broad, semi-elliptical curve, which is slightly flattened along the front of the test.

Ventral valve most prominent at or just posterior to the middle, and furnished with a median fold, more or less elevated above the surface of the valve, and formed of two, rounded, prominent plications, each of which is very small where it commences at the beak, and increases rather rapidly in size towards the front. The plications are separated by a rounded or slightly flattened, and generally well defined reverse plication, and each slopes more or less abruptly on the outer side, to a still larger reversed plication, beyond which the sides of the valve slope to the lateral margins with little or no curvature, generally making the valve somewhat broadly subcarinate along the median line. The fold increases very gradually in height from the beak, and the curve along its top is generally quite strong, sometimes becoming

slightly straightened towards the front. Beak small, acute, and but slightly extended beyond the hinge area, of which it is impossible to determine the exact size and shape, since it is invariably concealed by the rock.

Dorsal valve flat, or curving gently from the beak to the front and sides, with a well defined sinus along the median line, corresponding with the fold of the ventral valve, and which, narrow at the beak, increases gradually in width, becoming moderately deep at the front. A rounded, prominent plication occupies the bottom of the sinus, and the margins curve up abruptly to form a large plication on each side.

There are four or five, seldom six, broad, rounded, plications on each side of the fold and sinus, separated by depressions of a similar character. There is a great variation in the size of the plications, which are much larger in some specimens than in others. Those of the ventral valve are, however, always narrower than the intervening depressions; while on the dorsal valve the depressions are the narrower. The plications extend nearly directly from the beak to the margins, arching somewhat strongly along the top near the fold in the ventral valve, but less and less so, becoming smaller, and less distinct towards the cardinal angles, which are sometimes flattened or even slightly reflected, and are smooth in both the valves. There are usually several lines of growth. The entire surface is traversed by very fine radiating raised lines, which rise at regular intervals into minute, hollow spines, with elongated bases, the inner surface of the test showing their position as slight depressions. The minute surface markings are seldom seen on the specimens from the sandstone, which, even when best preserved, show only the bases of the spines, and those very indistinctly. But several moulds of valves, obtained from the underlying yellow shales, have the impressions of the raised lines and the spines well preserved.

The impressions of the hinge teeth are shown in the moulds of the ventral valve, and in the interior moulds of the dorsal valve the impressions of the processes are partially preserved; but on account of the coarseness and friable character of the sandstone in which they occur, we cannot depend upon them as being at all perfect. The cardinal process is somewhat angular behind, and the socket plates are rather broad at the base, but become narrow along the top. The septum is short and low.

A ventral valve of ordinary size measures 11 m. m. in length, 15 m. m. in width and about 3 m. m. in height, but specimens are often found much larger, one being 16 m. m. long, 25 m. m. broad and about 5 m. m. high.

There would be no difficulty in separating the Erie specimens of *Vitulina* from the small forms of *V. pustulosa*, Hall, described and figured in Vol. IV of the Pal. of New York. But since Prof. Hall wrote the description of this species, he has obtained a great number of specimens from other localities than the first, many of which differ much from those first described, frequently being

larger, with the depression in the median fold and the plication in the median sinus well defined. Thus we have forms which approach so closely those from Ereré, that it is impossible to separate the two. They are undoubtedly identical.

Obtained in great abundance from the Devonian sandstone of Ereré, associated with *Spirifera Pedroana*, etc. A few specimens have also been found in the yellow shale underlying the sandstone. (Morgan Expeditions 1870 and '71.)

Discina lodensis, *Hall.*

Orbicula lodensis, Hall, Geol. Rep. Fourth Dist. N. Y., p. 223.
Orbicula lodensis, Vanuxem, Geol. Rep. Third Dist. N. Y., p. 168.
Discina lodensis, Hall, Pal. N. Y., Vol. IV, p. 22.
Compare *Discina media,* Hall, Pal. N. Y., Vol. IV, p. 20.

Test of the Ereré variety small, subcircular or broadly subovate in outline; breadth about equal to the length, and greatest at, or slightly anterior to, the middle; generally narrowing more or less posteriorly, and often slightly truncate behind.

Both valves are always so flattened in the shale, that their true convexity is undeterminable. The nuclei, which were probably acute, at least in the dorsal valve, are also flattened down to the surface of the valves and broadened. Their distance from the posterior margin varies with the age of the test, it being, in the dorsal valve, from about one-third the length of the valve in the very young, to about one-fifth the length in full grown specimens; but in the ventral valve, their distance from the posterior margin is always somewhat greater than in the dorsal valve, averaging about one-third the length of the valve, thus giving more space for the foramen, which is narrow, linear, and extending from very near the nucleus to within a varying distance from the posterior margin. The concentric lines of growth are numerous, rather fine, yet prominent, and more closely crowded together posterior to the nuclei.

The larger specimens measure in length and breadth about 8 m. m., and there are all sizes from this down to individuals of very small size.

This *Discina* from Ereré, is undoubtedly only a variety of *Discina lodensis*, Hall, Genesee shale, New York. The Brazilian variety, together with *D. lodensis* and *D. media*, Hall, of the Hamilton and Chemung groups, probably forms a single species, which extends through all the latter portion of the Devonian age of North America, and has also a wide geographical range; the specimens varying somewhat, according to the conditions under which they lived, and the rock in which they are preserved.

Obtained in great abundance from the dark shales of the Devonian of Ereré, in various stages of growth, with *Lingula Monte-Alegrensis*, etc. (Morgan Expeditions 1870 and '71.)

Though only six specimens of *Lingula* were obtained at Ereré, these appear to represent, at least, four determinable species, one of which may prove to be identical with *Lingula spatulata* of the Genesee shale, New York, while the others seem to be new to science.

Lingula spatulata? Fig. 1.

Lingula spatulata, Hall and Van., Geol. Reps., 3d and 4th Districts New York, 1842 and '43.

Lingula spatulata, Hall, Pal. N. Y., Vol. IV, p. 13.

The only specimen of this species found at Ereré, consists of a single valve, which is small and half as wide as long. The strongly rounded front, and sub-parallel, nearly straight, lateral margins, forming a somewhat elliptical outline. The posterior third of the valve is angular, the margins being inclined towards one another at an angle of about 70 degrees. Being defective at the apex, it is impossible to determine the original form of the beak, though it was probably acuminate and strongly elevated. The valve is very convex, flattened toward the front, from which it rises gradually nearly to the beak, toward which it slightly declines. In the front and middle the valve curves regularly from side to side, but, toward the beak, it becomes very slightly subangular along the median line.

L. Spatulata, Hall.

Faint traces of the substance of the test appear to be preserved, and the lines of growth are indistinctly visible. Length 9 m. m., width 4.5 m. m.

Although this specimen of *Lingula* is much larger than the specimens of *Lingula spatulata* from New York, yet the outline is so nearly the same, that it does not seem possible to separate the Ereré form from the New York forms, more especially since a variety of *Lingula spatulata* has been obtained from the West, which is much larger than the one from New York.

This is the only species of *Lingula* yet detected in the Devonian sandstone at Ereré, where it was found associated with *Spirifera Pedroana*, etc. It is readily distinguished from the species of the underlying dark Discina shale by being more angular posteriorly. (Morgan Expedition 1871.)

Lingula Graçana, *Rathbun,* sp. nov., fig. 2.

*L. Graçana.**

In the only specimen of this species yet obtained, the test is small and elongate, the greatest width, which is just behind the middle, being equal to about one-half the length. The outline is elliptical, the lateral margins being very slightly straightened and inclined towards the front; beak indistinct; surface, where preserved, marked with numerous, exceedingly minute, closely arranged, concentric lines, together with a few, coarse growth-lines, imperfectly preserved in the specimen. The valve is very flat, but this may be the result of pressure. Length 6.5 m.m., width 3.5 m.m.

This species, which somewhat resembles in form certain varieties of *L. mytiloides, Sow.*, of the Carboniferous of England, occurs with *Discina lodensis* in the dark shale of the Devonian, near the Igarapé de Ereré, Province of Pará, Brazil. (Morgan Expedition 1870.)

Named in honor of His Excellency, Dr. Abel Graça, President of the Province of Ereré in 1870 and '71, to whom Prof. Hartt is indebted for the use of the steamer Jurupensem on his Expedition of 1870.

Lingula Stauntoniana, *Rathbun,* sp. nov., fig. 3.

L. Stauntoniana.

This species is represented by a very perfect, though probably flattened impression of a single valve; but, notwithstanding that it preserves faint indications of muscular markings, I have not been able to determine whether the valve is ventral or dorsal. The valve is small, a little longer than broad, the greatest width being at about one-fourth the length from the front. In its posterior three quarters it narrows backward, the margin being regularly elliptical in outline, and consequently bluntly rounded behind, without a distinct beak. In the anterior fourth of the valve the margin, nearly straight in front, curves rather abruptly round on each side to meet the lateral margins, so that the general outline of the valve is an oval, slightly flattened in front. The V-shaped line, shown in fig. 3, appears to represent the anterior limits of the muscular impressions. Length 8.5 m.m., breadth 6.5 m.m.

This species occurs associated with *Discina lodensis* in the dark shale near the Igarapé de Ereré, Province do Pará, Brazil. (Morgan Expedition 1871.)

Dedicated to Mr. Phineas Staunton, a member of the Expedition of 1870.

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*I have given only an outline drawing of this species of *Lingula*, since it is impossible to represent accurately its surface markings in a wood cut.

Lingula Rodriguezii, *Rathbun*, sp. nov.

Dorsal valve rather large, elongate, and oblong in outline. Front very slightly rounded, but curving somewhat strongly to meet the lateral margins, which, curving but slightly, extend backwards nearly parallel with one another for about three-fourths the length of the valve. The posterior lateral margins incline towards one another at an angle of about 100 degrees, and the beak is apparently a little rounded. The outline of the valve is very defective, but I have been able, I think, to trace it out very satisfactorily from the rather numerous lines of growth, which are quite well preserved on the front; but the valve is so crushed that it is impossible to determine its convexity.

The impressions of the several muscular markings are more or less perfectly preserved. They show that the valve is dorsal. The impression of the pedicle muscle is not preserved, but just in front of the place where it should be, are two small crescent-shaped impressions, placed closely together and apparently more deeply excavated in the substance of the test than are the other muscular markings. The markings left by the decussating muscles seem to be narrow and elongate, but the outline is indistinct. They are apparently situated at the sides of a raised, circular disc, from the front of which extends a short, low and rather broad median crest, but the test is so broken that the appearance of a disc and crest may not be natural. On each side of this crest are the impressions of the posterior adductors, which seem to be unusually small, while the subelliptical impression of the anterior adductors in front of the crest is also very small. One or two narrow, faint, curving depressions extend forward from the front of the impressions of the decussating muscles, and probably denote structure. There is a V-shaped line on the forward portion of the disc, apparently of the same character. Length 22 m. m., breadth 13 m. m.

Obtained from the yellow shale underlying the sandstone at Ereré.

Dedicated to Dr. J. C. Rodrigues, Editor of the Novo Mundo, New York, one of the most prominent patrons of the Morgan Expeditions of 1870 and '71.

Although the fossils so far obtained from Ereré, were collected from so small an area and so limited a thickness of rock as to render it unsafe to draw any extended or definite conclusions from them; yet the Brachiopod fauna, such as it is, resembles so closely that of the Hamilton group of New York State, as to leave no doubt that the beds in which it was found, the sandstones and shales of Ereré, represent about the same horizon as the Hamilton group of North America. Not only are characteristic Hamilton group

genera found in the Ereré beds, but even species of those same genera, which cannot be separated from North American species of the Hamilton group.

Spirifera Pedroana, so abundant at Ereré, seems to represent, not a single species of the Devonian, but several, which form a series extending through the Corniferous and Hamilton groups. The different species of this series are very distinct from one another in their extreme forms, but they are so connected by intermediate varieties, that they present a good subject for the study of development. The series includes in North America *S. varicosa* and *S. macra* of the Corniferous, and *S. medialis*, *S. macronota* and *S. angusta* of the Hamilton. *Streptorhynchus Agassizii*, the most abundant fossil at Ereré, belongs to that transition group of the *Streptorhynchi* which helps to characterize the Devonian; yet, so far as at present known, the new species does not attain the large size of the Devonian species of that genus elsewhere. The genus *Vitulina* has been known by only a single species, which is confined to the Hamilton group of New York, and was considered rare, but somewhat recently it has been found in greater abundance. The Ereré form does not differ from the larger varieties of *V. pustulosa*, Hall, of the Hamilton group. The Ereré *Tropidoleptus* is identical with the uncarinate forms of *T. carinatus* from the Hamilton group of New York. Though only a very few specimens of *Rhynchonella* have been obtained from Ereré, there is little difficulty in uniting them with *R. dotis* of the Hamilton. The genus *Chonetes* is represented by several species, all of which are closely related to Hamilton group species of New York. The single species of *Discina*, and one of the species of *Lingula*, are probably only varieties of North American Hamilton group species. It may appear strange that many of the most common genera found in the Devonian, such as *Atrypa*, *Strophodonta*, *Productella*, etc., are wanting, while more obscure genera are abundantly represented; but when we consider that the collections were made over an area of only a few feet in extent, and from a thickness of but a few inches, we must see that it is just what might be expected.

EXPLANATION OF PLATE VIII.

(*Figures all of natural size.*)

Spirifera Pedroana, *Hartt,* sp. nov., page 237.

1, 4, 5 and 17. Ventral valves of large size. In fig. 4 the dental plates are seen to be rather long.

2, 9, 13, 16 and 18. Ventral valves of medium size.

14. Small ventral valve.

19. Ventral valve, somewhat larger than fig. 14, inclined slightly forward, so as to show the hinge area in part.

8. Hinge area of ventral valve, with the margins of the fissure partly broken away.

3 and 7. Large dorsal valves.

6 and 20. Dorsal valves of medium size.

Spirifera Elizae, *Hartt,* sp. nov., page 239.

15 and 21. Ventral valves. Fig. 21 is the most perfect specimen yet found, while fig. 15 is much broken, and its dental plates are slightly curved.

Spirifera Valenteana, *Hartt,* sp. nov., page 241.

11. An interior mould of the ventral valve, the only specimen of this species obtained.

Rhynchonella (Stenocisma,) dotis, *Hall,* page 246.

10 and 12. Dorsal valves. In fig. 12 the margins of the valve are partially obscured by the rock, in which it is embedded.

(All of the above specimens are interior moulds.)

EXPLANATION OF PLATE VIII.

(Figures all of natural size).

By a mistake of the heliotyper this plate was reversed and numbered backward. The following are the corrected references:—

SPIRIFERA PEDROANA, *Hartt*, sp. nov., page 237.

5, 17, 18 and 21. Ventral valves of large size. In fig. 18 the dental plates are seen to be rather long.

4, 6, 9, 13 and 20. Ventral valves of medium size.

8. Small ventral valve.

3. Ventral valve, somewhat larger than fig. 8, inclined slightly forward, so as to show the hinge area in part.

14. Hinge area of ventral valve, with the margins of the fissure partly broken away.

15 and 19. Large dorsal valves.

2 and 16. Dorsal valves of medium size.

SPIRIFERA ELIZAE, *Hartt*, sp. nov., page 239.

1 and 7. Ventral valves. Fig. 1 is the most perfect specimen yet found, while fig. 7 is much broken, and its dental plates are slightly curved.

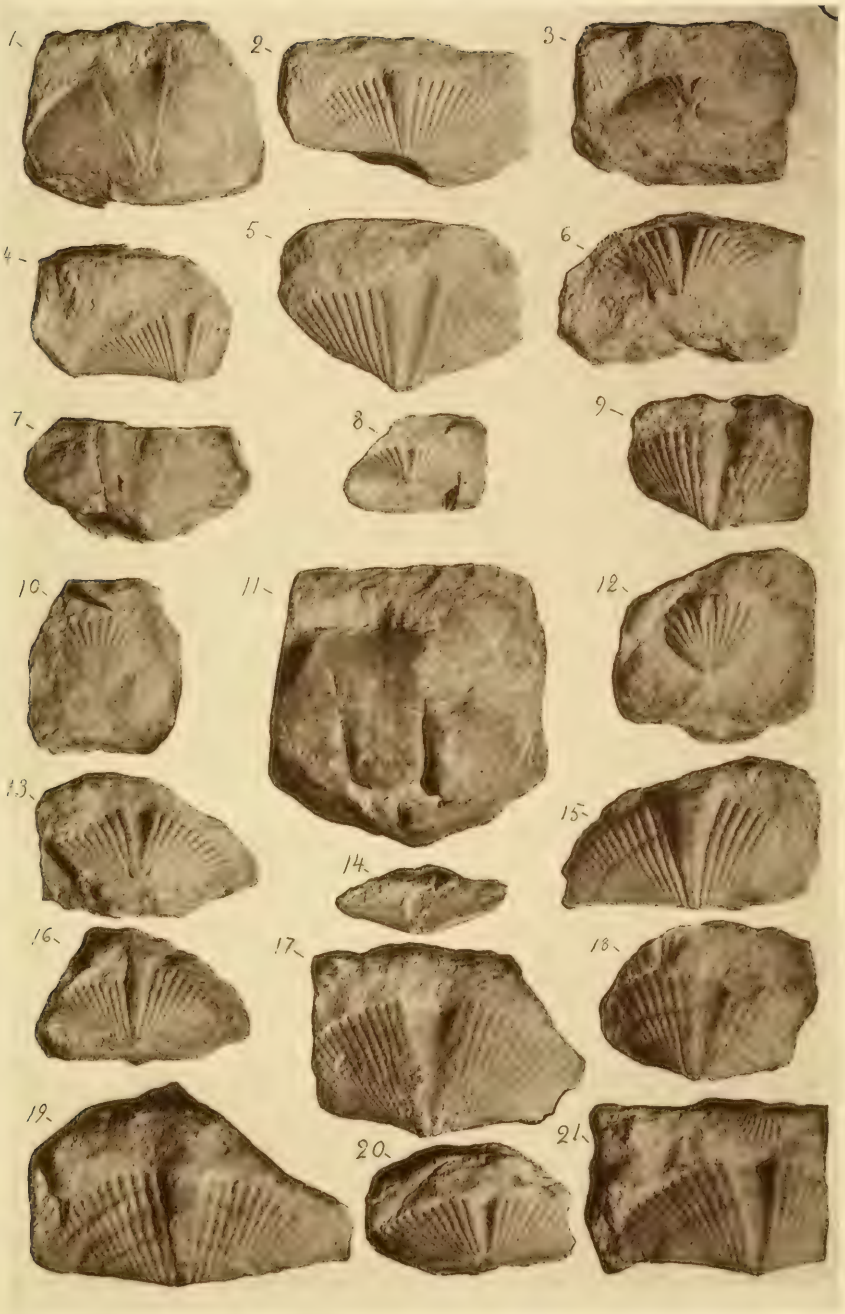
SPIRIFERA VALENTEANA, *Hartt*, sp. nov., page 241.

11. An interior mould of the ventral, valve the only specimen of this species obtained.

RHYNCHONELLA (STENOCISMA,) DOTIS, *Hall*, page 246.

10 and 12. Dorsal valves. In fig. 10 the margins of the valve are partially obscured by the rock, in which it is embedded.

(All of the above specimens are interior moulds.)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EXPLANATION OF PLATE IX.

(*Figures all of natural size.*)

Tropidoleptus carinatus, *Con.,* (sp.,) page 254.

1 and 9. Ventral valves. In fig. 1 the plications are very indistinct.

Vitulina pustulosa, *Hall,* page 255.

2, 7, 8, 12, 13, 15, 20, 21 and 27. Ventral valves. In figs. 7, 8 and 15, there are three medium sized plications on the fold, instead of two large ones.

6, 11 and 32. Dorsal valves. Fig. 11 shows the impressions of the dental plates.

Streptorhynchus Agassizii, *Hartt,* sp. nov., page 248.

10. Small ventral valve, on which the radiating raised lines are well preserved and sharp.

16. Gutta percha impression of an exterior mould of a large ventral valve.

17. Very large ventral valve.

23, 26 and 28. Ventral valves of medium size.

3. Dorsal valve, medium size.

4, 25 and 29. Rather large dorsal valves.

30. Interior and exterior moulds of small dorsal valves, with the raised lines sharply preserved.

Chonetes Comstockii, *Hartt,* sp. nov., page 250.

5, 14, 18, 19 and 31. Ventral valves.

Spirifera Elizae, *Hartt,* sp. nov., page 239.

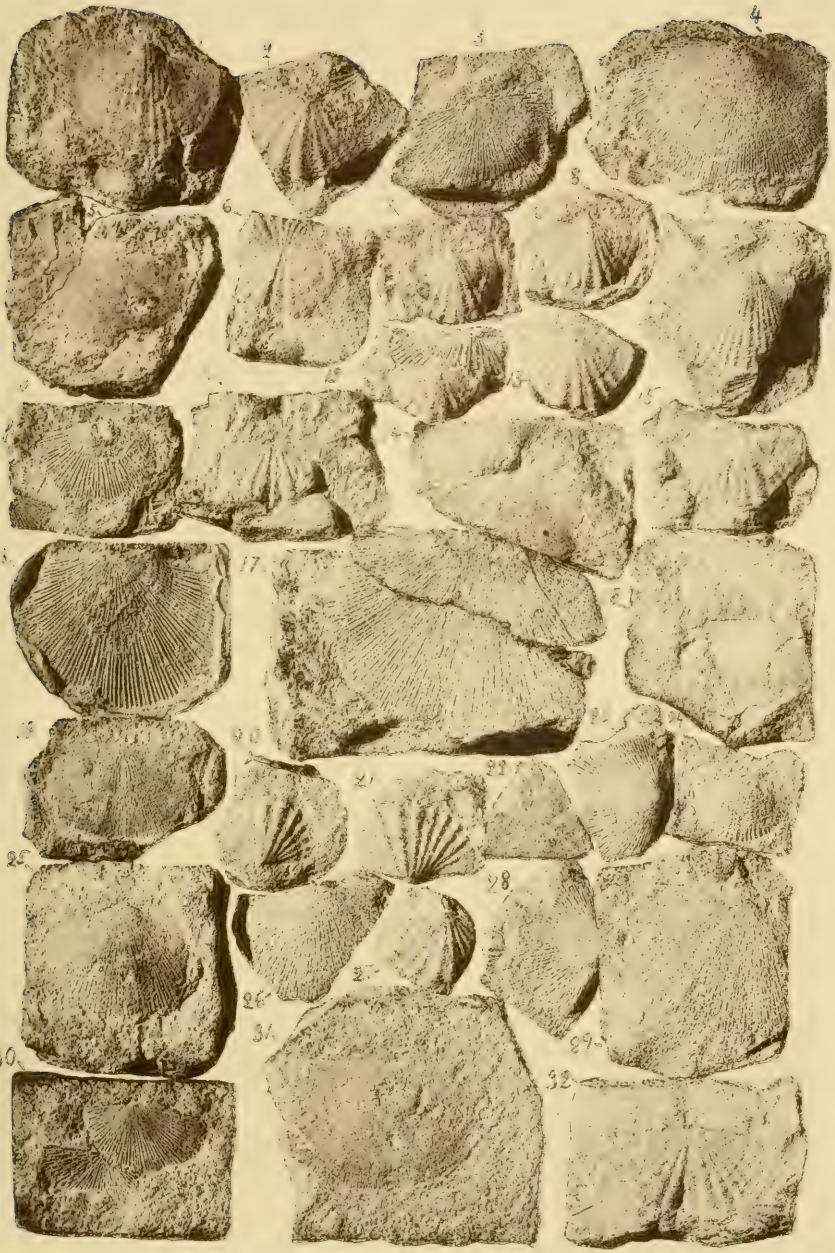
22. Fragment of ventral valve, from the dental plate of left side to left cardinal extremity.

Chonetes .....? *Hartt,* sp. nov., page 253.

24. A ventral valve, the only specimen found.

(Unless otherwise stated, the above specimens are all of interior moulds.)

IX.



EXPLANATION OF PLATE X.

(Figures all of natural size.)

Cyrtina? Curupira, *Rathbun,* sp. nov., page 242.

1 and 6. Dorsal valves.

Retzia Wardiana, *Hartt,* sp. nov., page 245.

3, 4, 5, 8, 11, 12 and 14. Ventral valves.

16. Ventral valve, with the plications finer and more numerous than in the majority of specimens.

2 and 9. Dorsal valves.

Orthis Nettoana, *Rathbun,* sp. nov., page 247.

7 and 13. Ventral valves.

10. Dorsal valve.

Terebratula Derbyana, *Hartt,* sp. nov., page 236.

15, 18, 24 and 25. Ventral valves.

17, 19, 21 and 22. Dorsal view of specimens of which both valves are preserved. The beaks of the ventral valves are seen extending beyond the dorsal valves, but in all the specimens they are more or less defective.

20. Dorsal valve.

Tropidoleptus carinatus, *Con.,* (sp.,) page 254.

26. Exterior mould of dorsal valve, very much broken.

Retzia Jamesiana, *Hartt,* sp. nov., page 243.

29, 33, 34, 36, 37 and 38. Ventral valves, showing the enlarged median depression.

27, 28, 31, 32 and 35. Dorsal valves.

30. View of dorsal valve of a specimen in which both valves are preserved. The beak of ventral valve is slightly extended beyond the dorsal valve.

23. Dorsal view of a rather narrow specimen, of which the ventral valve is also preserved. The plications are less in number than usual.

Chonetes Herbert-Smithii, *Hartt,* sp. nov., page 251.

39, 41, 42 and 46. Ventral valves of ordinary size.

44. Ventral valve, same as above, but smooth from the character of the rock in which it occurred.

40. Ventral valve, rather above the average size.

45 and 47. Exterior moulds of dorsal valves.

Chonetes Onettiana, *Rathbun,* sp. nov., page 253.

43 and 48. Ventral valves, with nearly smooth surfaces and showing the short median septum very distinctly.

(Except where otherwise stated, the above specimens are all of interior moulds.)

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